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The initial reliability and construct validity of the Autism Spectrum Disorder-Diagnostic (ASD-DC) in children

Melissa Luke Gonzalez
Louisiana State University and Agricultural and Mechanical College

THE INITIAL RELIABILITY AND CONSTRUCT VALIDITY OF THE AUTISM SPECTRUM DISORDER-DIAGNOSTIC (ASD-DC) IN CHILDREN

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Melissa L. González
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ABSTRACT

The aim of the present study was to examine the reliability and construct validity of a newly developed assessment scale designed to identify autism spectrum disorders in children: Autism Spectrum Disorder-Diagnostic for Children (ASD-DC). Participants were parents and caregivers of children between ages 2 and 16 years, who are typically developing or developmentally delayed. Participants were asked to complete several rating scales including the ASD-DC, a DSM-IV-TR/ICD-10 checklist, the Matson Evaluation of Social Skills in Youngsters (MESSY), and the Behavioral Assessment System for Children, Version 2 (BASC-2). In Study 1, the test-retest, inter-rater, and inter-item reliabilities of the ASD-DC was examined. After initial reliability analysis, the scale was reduced to 37 items. The ASD-DC was found to have good to excellent inter-rater reliability, and excellent test-retest reliability. The 37 item scale had excellent internal consistency ($\alpha = .99$) and adequate item-scale correlations. In Study 2, the construct validity of the ASD-DC was investigated by evaluating the pattern of correlations (i.e., convergent and divergent validity) among the administered scales utilizing a correlation matrix. The ASD-DC converged with another measure of autism (i.e., DSM-IV-TR/ICD-10 checklist) and other associated symptoms of ASD. Further, divergence was observed when the ASD-DC was correlated with measures of social skills and functional communication. Based on the results of this initial study of the ASD-DC, the psychometric properties of this new scale are promising and warrant further investigation. Implications of these findings and future directions are discussed.

INTRODUCTION

Over the past decade, there has been an overwhelming focus on autism spectrum disorders (ASD). Although autism is by no means a new childhood disorder, political interest and funding has brought this disorder to the forefront of the media and, thus spurred a vast amount of scientific investigation. This renewed interest in autism has greatly changed the way clinicians, as well as the public, conceptualize the broader spectrum of ASD. The present study aims to investigate the psychometric properties of a newly developed assessment scale designed to identify children with ASD. A brief overview of the history of ASD, the characteristics and diagnostic criteria, as well as the epidemiology and etiology will be discussed. Then, available assessment methods will be reviewed. Finally, the current study will be proposed. It should be noted that ASD (also referred to as pervasive developmental disorders, PDD) in DSM-IV, will be the term used throughout this manuscript to refer to the group of disorders characterized by varying degrees of impairment in social interactions, communication skills, and restricted, repetitive, or stereotyped patterns of behavior or interests.

History of Autism Spectrum Disorders

Autism

Though our understanding of ASD has evolved over time, it is Leo Kanner's (1943) description of a childhood disorder he termed *autistic disturbances of affective contact*, on which our current conceptualization of autism has its basis. In 1943, in his seminal paper, Kanner described 11 children lacking typical motivation for social interaction, with disturbances in communication such as muteness, echolalic, and/or literal speech. These children were also resistant or sensitive to environmental changes, manifested repetitive or ritualistic patterns of behavior, and were fascinated with objects. Kanner used the term *autism* to reflect the idiosyncratic, self-centered quality of the disorder (Volkmar & Klin, 2005). He also proposed

that these deficits or impairments were present at birth and were biological in nature. Later revisions by Eisenberg and Kanner (1956) highlighted features of the disorder related to self-isolation and insistence on sameness, and added that the onset of autism occurred prior to age 2.

While Kanner's initial description of impairments in social interaction, communication, and insistence on routine or sameness continues to be considered hallmark symptoms of this disorder, he also believed that autism was not related to other medical conditions. He suggested that children with autism were not intellectually disabled, but rather poor performance on parts of tests of intelligence (i.e., typically verbal subtests) was due to a lack of motivation. However, these later suggestions made by Kanner have since been refuted by scientific evidence. Current evidence indicates that up to 25% of children with autism also have a seizure disorder (APA, 2000; Tidmarsh & Volkmar, 2003). Further, many estimates suggest that up to 75% of children with autism (i.e., excluding those classified in the broader spectrum) have some level of intellectual disability (ID; Rutter, 1968; Rutter, Bailey, Bolton, & LeCouter, 1994) that is stable over time (Lockyer & Rutter, 1970).

The severity of the disorder and the term used to describe it led many clinicians to suggest that autism was an early form of schizophrenia (Bender, 1946). Prior to Kanner's descriptions, the term "autism" had been used by Bleurer to describe the social withdrawal of individuals with schizophrenia (Rutter, 1978). Thus, the early autism literature is sprinkled with references to childhood schizophrenia. Creak (1961) described what was referred to as the *early child psychosis*, which involved nine characteristics: 1) impairments in emotional relationships, described as aloofness and difficulty with social play; 2) lack of awareness to personal identity, described as abnormal body posturing, self-injurious behavior, difficulty with the use of personal pronouns in expressive language; 3) abnormal preoccupation with characteristics or parts of objects, rather than an interest in the function of the object; 4) resistance to environmental

change and an insistence on sameness; 5) abnormal response to perceptual experiences and environment stimuli, such as insensitivity to pain or hypersensitivity to sounds or smells; 6) acute or excessive anxiety typically associated to changes in the environment; 7) loss of speech or failure to acquire language, and abnormal speech patterns including echolalia or pronoun reversal; 8) distorted pattern of motility described by abnormal gait, body posturing, and movements; and 9) intellectual impairment, although some children may have normal or exceptional intellectual functioning. Many of these characteristics overlapped with Kanner's descriptions of autism. As Creak failed to indicate how these behavior patterns were specific to childhood psychosis, many of these criteria have been associated with autism over the years and have been incorporated in assessment measures (Matson & Minshawi, 2006). It should be noted that several points are evident that distinguish autism from schizophrenia including the onset patterns, course, and family genetics (Evloff, 1960; Romanczyk, Lockshin, & Harrison, 1993).

In the 1960s professionals and parents of children with autism began to organize themselves politically in order to advocate for these children's education and treatment services (Wing & Potter, 2002). As autism has been described as a syndrome with diverse characteristics, there was much confusion in what symptoms constituted a diagnosis of autism. During the late 1960s and early 1970s, the research of Michael Rutter and Edward Ritvo, chairman of The National Society for Autistic Children (NSAC), did much to clarify the core symptoms of autism (Schopler, 1978). Each proposed their own definition.

The literature at that time was filled with varying clinical accounts and suggested criteria. Rutter's review of the literature called for a return to Kanner's original observations and further scientific investigation to test the hypothesis put forth by Kanner (Rutter, 1978). He differentiated between behaviors that were associated with autism and those that were characteristic of autism but were distinct from other disorders. Rutter (1978) characterized

autistic symptoms into three broad groupings of behaviors: 1) failure to develop social relationships relative to the child's intellectual ability; 2) delayed or impaired language development and comprehension relative to the child's intellectual ability; and 3) insistence on sameness or ritualistic behavior. Further, Rutter proposed a final criterion of symptom onset prior to 30 months.

In terms of language and pre-language skills, children with autism typically have delayed language acquisition. The pattern of language development is distinct from their non-autistic counterparts. Autistic children typically do not show social imitation (i.e., waving good-bye), which are pre-language skills. As young children, they are often delayed in their meaningful use of objects and lack imaginative or creative play. These children also have impaired understanding of spoken language; they must often rely on the familiar social context or gestures. Pronomial reversal is common (i.e., reversing "You" and "I"). They typically have difficulty with reciprocal conversation and exhibit echolalia. Many children with autism never gain useful speech (Rutter, 1978).

Specific characteristics associated with impaired social relationships include a lack of affection, cuddling, or attachment toward the caregiver. This is most noticeable within the child's first 5 years. Examples include the view that children tend to isolate themselves from their parents around the house, do not gesture to parents that they want to be held, nor run to greet them after an absence. Further, these children typically do not go to their parents to be comforted when they are hurt or upset. Moreover, there typically is a lack or abnormal use of eye-to-eye gaze. As the child grows older, other social impairments are noted in cooperative play with other children, such as a failure to make friends and a lack of empathy or ability perceive other people's feelings. These deficits in social relating often result in the child engaging in socially inappropriate speech or actions towards others (Rutter, 1978).

Restricted interest may be exhibited as rigid or limited play patterns that lack variety and imagination (e.g., lining up toys or collecting objects). The children may be attached to objects and determined to carry the objects with them without regard for their functionality. If the object is removed, the child will protest. Similarly, the child may be resistant to changes in the environment, such that if something is moved the child will become extremely distressed. As the child grows, unusual preoccupations may develop that may involve bus routes, train timetables, colors, numbers, patterns, or simply asking questions in which a specific answer is expected. These restricted interests typically involve most of the child's time to the exclusions of most other activities. Ritualistic and compulsive behaviors are also common. These may be in the form of rigid routines or compulsive touching (Rutter, 1978).

Rutter (1978) also added that stereotyped repetitive movements, a short attention span, self-injury, and delayed bowel control were more common in children with autism, but were not always present. Further, he suggested that mental age (i.e. intellectual level) and neurological status must be taken into account when assessing behavior, as ID and neurological deficits frequently co-occur with autism.

Ritvo (1978) and the NSAC consensus definition of autism were somewhat different than that of Rutter's definition. NSAC defined autism as a behaviorally-defined syndrome in terms of the following essential features: 1) disturbances in the developmental rates and/or sequences within one or among more than one developmental pathway (i.e., motor, social-adaptive, cognitive); 2) disturbances in responses to sensory stimuli; 3) disturbances in speech, language, and cognitive abilities; and 4) disturbances in the capacity to relate to people, objects, and events. Similar to Rutter, the NSAC suggested that these features are present prior to 30 months of age.

Disturbances may include different rates of development within a single pathway, such that the child may have typical gross motor development but may have impaired fine motor

abilities. Alternatively, a child with autism may exhibit different rates of development between pathways; whereas, the child may exhibit typical motor development, but delays in cognitive development. Finally, a child with autism may exhibit arrests or regression in developmental pathways, such that development appears to be typical until a certain age, where the child appears to lose skills or stop developing skills. For example, imitative or speech skills may be typical until the age of 2, then language skills regress. Alternatively, speech may be delayed in onset and then subsequently followed by rapid acquisition (Ritvo, 1978).

A child with autism may have an unusual response to sensory stimuli. These unusual responses can vary from abnormalities in activity level (i.e., hyperactivity, hypoactivity), which may alternate and change over time; visual senses (i.e., lack of eye-contact, staring, close attention to visual details or changes in illumination); auditory senses (i.e., appearing more sensitive or oversensitive to certain sounds that may not be noticed by others; or non-responsive to certain sounds); tactile senses (i.e., under- or over-responsiveness to touch, pain, or temperature, prolonged rubbing of textures, and/or selectivity of food or clothing textures); vestibular symptoms (i.e., preoccupation with spinning objects or repetitive self-whirling without experiencing dizziness); olfactory and gustatory senses (i.e., repetitive sniffing of objects, specific food preferences, and licking of inedible objects); and proprioceptive symptoms (i.e., posturing, lunging movements, hand flapping, and grimacing). These features may vary over time within the same child (Ritvo, 1978).

Impairments in speech vary widely and may include mutism, delayed onset, immature syntax and articulation, and abnormal inflection or rhythm. In terms of language, a child with autism may have limited capacity to understand symbols or abstract terms, concepts, or reasoning. Further, it is not uncommon for the child to exhibit immediate or delayed echolalia

and use of neologisms. Nonverbal communication may also be impaired. The child may fail to use gestures or understand the gestures of others (Ritvo, 1978).

Difficulty in relating to others may be manifested by an absence or delay in a smiling response, stranger anxiety, reciprocal use of eye contact, and an absence of child interaction games such as peek-a-boo, pat-a-cake, or waving bye-bye. Perhaps the most notable impairment is in the development of relationships with significant caretakers or peers (i.e., friendships typically develop between ages 2 and 4). Over time, responses to adults or peers may develop, but these responses are typically superficial, immature, and under the control of strong social cues. Use of objects may also be impaired. For instance, the child may fail to use toys or other objects in an age-appropriate behavior. Objects are frequently used in an idiosyncratic, stereotypic or preservative manner. Further, if someone interferes with the child's use of this object, the child may panic or become upset. Finally, a child with autism may be acutely aware of the sequence of certain events; if this sequence is disrupted, the child may become distressed (Ritvo, 1978).

The NSAC also indicated some associated features of this disorder. Mood lability, such as unexpected and inconsolable crying or laughing without an identifiable stimulus, is often noted in this population. Further, lack of appreciation of danger and inappropriate fears have been associated. Self-injurious and stereotypic behaviors are frequently present. As indicated by Rutter (1978), the NSAC also noted that intellectual impairment and seizures are also common co-occurring features (Ritvo, 1978).

While there is substantial overlap in the symptoms described by Rutter (1978) and Ritvo (1978), these definitions do differ in terms of what they determine to be the essential or core characteristics of the disorder. Both Rutter (1978) and Ritvo (1978) agree that social impairments, deficits in language and cognitive skills, and symptom onset prior to 30 months are

critical features of the disorder. However, the definitions diverge in terms of how certain symptoms are conceptualized (e.g., insistence on sameness as an essential feature alone, or as part of a disturbance in relating to people, events, and objects; disturbance of developmental rates as a primary feature itself, or as a frame of reference for primary features). Rutter proposed his definition from historical and scientific perspective, while Ritvo's definition was formed for the purpose of political and social action to fund treatments for children with autism (Schopler, 1978). Overall, these descriptions have contributed much to the current diagnostic/assessment technology employed for autism in children.

Wing and Gould (1979) carried out an epidemiological survey to examine the prevalence and occurrence of symptoms associated with autism (i.e., impairments in social interaction; abnormalities of language development; and, repetitive, stereotyped behaviors); how cases exhibiting these symptoms may be sub-grouped; and, finally, how these symptoms were related to the presence of an ID. One hundred thirty-two children below the age of 18 who either exhibited impairments in one of three areas associated with autism (mentioned above) and/or had an ID (as indicated by a formal test of intelligence or achievement) participated in the survey. Teachers, nurses, staff, and parents were given a structured interview and the children were observed within a structured observation schedule. Based on the information obtained through the structured interviews and observations, the authors found that the quality of social interaction (aloof, passive + odd, sociable) reliably discriminated between groups based on behavioral, psychological, and medical variables within the sample. Seventy-four children were found to be socially impaired (socially aloof or passive but odd) and 58 were found to be sociable but severely intellectually disabled. All children with social impairments (only 17 with a previous diagnosis of autism) had repetitive stereotyped behavior, and most had an absence or abnormality in language or symbolic activities. Characteristics including presence of elaborate

and repetitive routines (at time of interview), idiosyncratic language, and pronoun reversal were found to distinguish those with a diagnosis of autism from other children. While repetitive activities and some language impairments were also found in the sociable children with severe ID, these aspects of behavior were part of a wider behavioral repertoire.

Children in the aloof subgroup tended to exhibit mutism and stereotyped activities, while the passive and odd subgroup were more likely to have repetitive speech and repetitive symbolic activities. Those in the aloof group tended to have an early age of onset (i.e., before 3 years of age). There was also a positive correlation between the severity of retardation and being identified as socially impaired. However, there were children who had severe or profound ID whose social interactions were appropriate for their developmental level. Given that only 17 children (34% in the aloof subgroup) of the 74 with social impairments had a previous diagnosis of autism based on Kanner's definition, Wing and Gould (1979) called for a broader definition of autism that is based on the full range of conditions involving impairments of social interaction. These researchers found that certain difficulties clustered together: absence or impairment in social interaction; absence or impairment in the use of language and/or comprehension; and absence or impairment in flexible or imaginative activities (i.e., the presence of narrow, repetitive, and stereotyped interest). This soon became the triad of deficits associated with ASD.

With the publication of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III; American Psychiatric Association, APA, 1980), autism along with several other childhood disorders were considered official psychiatric disorders with childhood onset. Infantile autism, along with other conditions (i.e., residual infantile autism; childhood onset pervasive developmental disorder, COPDD; and, atypical pervasive developmental disorder), was listed under a class of disorders called Pervasive Developmental Disorders (PDDs). The definition of infantile autism closely resembled the description put forth by Rutter (1978), described above.

The diagnosis of residual infantile autism was included for use in cases where the child once met the criteria for autism, but no longer met criteria. COPDD was included to account for those rare cases where children developed autism or autism-like symptoms after 30 months of age. Finally, atypical pervasive developmental disorder was a sub-threshold category for use in cases where children exhibited symptoms most closely resembling PDDs, but did not meet criteria for any one PDD specifically. Overall, this class of conditions (i.e., PDDs) conveyed that individuals with these diagnostic labels suffered from impairments in development in multiple areas of functioning. Further, individuals with hallucination and delusions were specifically excluded from a PDD diagnosis.

Soon after the DSM-III was published, revisions began (Volkmar & Klin, 2005). The definition of autism in DSM-III-R (APA, 1987) was strongly influenced by Wing and Gould's (1979) broader view of autism. Changes in this revision included the name of the disorder being changed to *Autistic Disorder* rather than *infantile autism* to highlight the lifelong nature of the disorder. Further, the revision included the removal of the age onset criteria, allowing the diagnosis to be given to individuals of any age, regardless of developmental history. There was an overall broadening of symptom criteria to incorporate developmental changes that may occur; criteria were worded more concretely and objectively when compared with DSM-III (Factor, Freeman, & Kardash, 1989). However, with this revision also came problems such as an increased false-positive rate of approximately 40%. The more complex and detailed examples listed in DSM-III-R limited clinician judgment, and the elimination of the age of onset was not consistent with Kanner's original descriptions or the current empirical data. Moreover, these changes increased the difficulty in comparing studies using International Classification of Diseases (ICD; World Health Organization) and DSM criteria at that time. Criteria set forth for

the ICD was much more conservative in diagnosing autism than that of DSM-III-R (Volkmar & Klin, 2005).

With the impending implementation of ICD-10, the development of DSM-IV began with the aim of increasing the clinical utility, reliability, and validity of the diagnosis, as well as making these two diagnostic systems more compatible. Extensive literature reviews, re-analysis of the data collected for the DSM-III-R, and a large multinational field trial were conducted in preparation for this revision. The field trial for autism involved 21 sites and 125 raters from the United States and around the world. Raters ranged in their professional experience with autism and professional background. Sites provided ratings on cases of children with autism and other disorders that would be differentially compared to autism (i.e., conduct disorders). Cases varied in ethnic background and educational histories. Multiple sources of information were made available to raters. A standard coding form was used to elicit information; criteria on the form were based on ICD-10 criteria and included possible criteria for Autistic Disorder, Asperger's Disorder, Childhood Disintegrative Disorder (CDD), and Rett's Disorder.

Data analyses revealed that age of onset had a moderate positive correlation with IQ. Individuals with later onset were more likely to have a slightly higher IQ. When the age of onset by 36 months criteria was added to the DSM-III system, the sensitivity increased. Thus, the addition of the age of onset criteria to the revision was supported. Overall, the reliability of the criteria was found to be in the good to excellent range (Volkmar & Klin, 2005). The experience of the raters regardless of their professional background had the greatest impact on reliability (Klin, Lang, Cicchetti, & Volkmar, 2000). The diagnosis was found to be stable over shorter periods of time (i.e. less than one year); however, the instability of the criteria were higher among younger children with lower levels of intellectual functioning (Volkmar & Klin, 2005). Based on these findings, the changes to the system instituted in this revision included the

addition of a criterion related to age of symptom onset; symptom criteria more closely resembling ICD-10 for compatibility purposes; and, criteria that cover a range of syndromes (including Asperger's Disorder, Pervasive Developmental Disorder-Not Otherwise Specified [PDD-NOS], CDD, and Rett's Disorder) that were applicable over the life span. More emphasis was given to criteria tapping into social deficits, as this was found to be important to avoid an over-diagnosis of autism in intellectually disabled persons, and which is consistent with Kanner's emphasis on impairments in social relationships (Volkmar & Klin, 2005).

As there is tremendous variability in symptom expression between children with autism and changes in symptoms over time, it is difficult to describe this disorder with an explicit definition (Volkmar & Klin, 2005). With this heterogeneity of symptoms across children, broader phenotypes of autism have been proposed (i.e., DSM-IV) such that deficits are conceptualized to be on a continuum. These disorders on that continuum are often referred to as autism spectrum disorders (ASD). The history of the other disorders on the spectrum, including Asperger's Disorder, PDD-NOS, CDD, and Rett's Disorder will now be reviewed briefly.

Asperger's Disorder

Approximately the same time Kanner first described autism, Hans Asperger (1944, as cited in Klin, McPartland, & Volkmar, 2005; Rutter, 1978; Wing 1981) of Austria, described a similar set of symptoms in 4 children between ages 6 and 11, which he termed *autistic psychopathy*. He described impairments in the following: 1) nonverbal communication; 2) idiosyncrasies in verbal communication; 3) social adaptation and special interests; 4) intellectualization of affect; 5) clumsiness and poor body awareness; and 6) conduct problems.

Nonverbal communication in these children differed from other children in that their facial expressions were fewer in number and diversity, they were limited in their use of gestures to communicate, and they had difficulties understanding the nonverbal cues of others. Verbal

communication, however, was often long-winded, incoherent, and tangential. Poor volume modulation (i.e., too loud) and atypical fluency (i.e., jerky speech) were also noted. Further, the children often had conversations that appeared to be one-sided (i.e., failing to signal a change of topic), and the tone and style of communication were pedantic.

Much like children with autism, these children often had special interest or preoccupations that absorbed most of their time and energy, which in turn precluded the acquisition of other self-help or social skills. As the child matured, special interests in topics such as astronomy, geography, electricity, or transportation systems tended to evolve into specific collections of encyclopedia-like knowledge. In addition, Asperger noted that many of these children had excellent rote memory of factual knowledge, but may not have grasped the full meaning or have been able to apply the facts they learned.

Socially, these children had poor empathy or understanding for others' feelings or communication, and had a tendency to intellectualize feelings. Due to their poor social understanding and circumscribed interests, behavioral problems including aggressiveness and noncompliance were commonly noted. These children were often bullied and teased by their peers. Finally, these children had poor coordination and body awareness including odd posture and gait, clumsiness, and poor hand-writing. Asperger associated these symptoms with the child's inability to participate in group sports or other self-help activities requiring coordination.

Asperger's autistic psychopathy was not introduced to English-speaking audiences until 1963, when Van Krevelen (1963, 1971) attempted distinguish Asperger's (1944) accounts from the descriptions put forth by Kanner (1943). While Asperger's description somewhat resembled Kanner's description of autism, it differed in several ways: 1) symptoms were not evident until age 3 or later; 2) speech and language acquisition were less often delayed; 3) Asperger's Disorder was not associated with ID; however, coordination and visuo-spatial impairments were

present; and 4) children who fit Asperger's description had a better prognosis than those described by Kanner. However, Rutter (1978) proposed that this disorder may be a mild form of autism, rather than a distinct syndrome.

There continues to be an on-going debate about whether Asperger's Disorder is distinct from autism or just a higher-functioning version of autism. Wing (1981) discussed the differential diagnosis of autism and Asperger's Disorder. In her review of his clinical cases, she suggested some additional characteristics of the syndrome. These included an overall lack of normal interest in others as a young infant or toddler, characterized by limited babbling, gesturing, or smiling at others. Further, she suggested children with Asperger's Disorder often have limited imaginative pretend play, which does not involve other children or have the variety typically found with same-aged peers. Wing (1981) also suggested some modifications to Asperger's description.

She pointed out that many (i.e., approximately half) children that Asperger identified with the disorder, did have delays in speech. Despite eventual gains in language or vocabulary, these children most frequently had impoverished content or understanding of the pragmatics of speech. Asperger described these children as capable of creativity. However, Wing (1981) proposed that the thought processes of these children are better described as narrow, pedantic, literal, and logical, rather than creative. She also highlighted that while many of these children were described as having special abilities in memory and described as being highly intelligent, most had poor comprehension and lacked common sense. However, others were found to have less than normal intelligence. Finally, Wing (1981) distinguished Asperger's Disorder from autism based on the severity of impairments. Socially, she described children with autism as "aloof and indifferent" and children with Asperger's Disorder as "passive or inappropriate" towards others. In terms of communication, children with autism may be mute or have delayed

speech; whereas, children with Asperger's Disorder tend to have good grammar and vocabulary, but poor content and comprehension. Where there tends to be a lack of gestures in children with autism, those with Asperger's Disorder tend to inappropriately use gestures. Both conditions are described as having abnormal or monotonous vocal intonation and focused interest. However, the interest of children with autism tends to be manifested in terms of stereotyped, repetitive routines, rules, or movements (i.e., arranging toys in a certain order, or following a specific ritual), while children with Asperger's Disorder typically have a preoccupation with facts or specialized topics (i.e., train schedules or the solar system). Children with autism have been associated with atypical sensory sensitivities (i.e. sounds, light, or textures), where children with Asperger's Disorder have not been associated in the same degree. Asperger's Disorder, on the other hand, is more closely associated with difficulties in motor coordination than children with autism. Previous studies, such as the epidemiological study conducted by Wing and Gould (1979), found that groups of children with autistic and autistic-like disorders could only be grouped under a general category as having the triad of impairments in social, communication, and restricted interests; the cases did not cluster based on the above mentioned distinguishing features of autism and Asperger's Disorder.

DSM-IV and ICD-10 definitions distinguish these disorders mainly on the basis of onset criteria. If concerns in communication, socialization, or symbolic play/imagination are noted prior to age 3, the diagnosis is autism. Further, if there is concern about cognitive development, self-help skills, or adaptive behavior (excluding social interaction skills), or if the child meets criteria for autism, then Asperger's Disorder would be ruled-out (APA, 2000). The current diagnostic system has been criticized for making the diagnosis of Asperger's Disorder improbable, as many higher functioning individuals appear to have onset prior to age 3. However, the question of whether Asperger's Disorder can be differentiated from autism using

DSM criteria continues to be discussed (Freeman, Cronin, & Candela, 2002). Tryon, Mayes, Rhodes, and Waldo (2006) investigated this very question by analyzing the symptoms of 26 children diagnosed with Asperger's Disorder and comparing these symptoms to a symptom checklist based on the current DSM-IV-TR criteria for autism, Asperger's Disorder, and PDD-NOS. These researchers found that when applying the DSM-IV-TR criteria, none of the 26 children previously diagnosed with Asperger's Disorder met the criteria for the diagnosis. Further, 77% (20 out of 26) of these children met criteria for autism, and 8% (2 out of 26) met criteria for PDD-NOS. The diagnosis of the remaining 15% (4 out of 26) was uncertain because cognitive data was unavailable; however, the authors suggested these participants met criteria for either PDD-NOS (if cognitive delay was present) or Asperger's Disorder (if cognitive delay was not present). Thus, it appears that clinicians do not strictly apply the current DSM-IV-TR criteria when giving diagnoses of autism and Asperger's Disorder. Overall, research has failed to support that clinical diagnoses of Asperger's Disorder meet DSM-IV-TR criteria (Mayes & Calhoun, 2001a; Tryon et al., 2006). Further, various studies have failed to show the validity of the use of speech and cognitive delay as distinguishing criteria for these disorders. The presence of early speech delays does not predict differences in autistic-like symptoms or later functioning in children with normal intelligence and autism or Asperger's Disorder (Eisenmajer et al., 1998; Mayes & Calhoun, 2001b). Moreover, Mayes and Calhoun (2004) found that when IQ and age are controlled, there are no differences in symptoms between children with autism and Asperger's Disorder. These findings along with others suggest that there may not be a meaningful distinction between high-functioning autism and Asperger's Disorder (Miller & Ozonoof, 2000; Ozonoof, South, & Miller, 2000; Prior et al., 1998).

Several conceptual modifications for Asperger's Disorder have been suggested to deal with these diagnostic difficulties, including: 1) conceptualizing these disorders on a spectrum of

deficits, whereby Asperger's Disorder is equated with high-functioning autism (Tryon et al., 2006); 2) distinguishing these disorders based on the child's early language development, whereby those with typical early language development (i.e., single words by age 2 and phrases by age 3) are diagnosed with Asperger's Disorder and those with language delays are diagnosed with autism; and 3) relying on more specific symptoms of Asperger's Disorder that are qualitatively different than those of autism (i.e., motivation to seek social interaction; Klin, McPartland, & Volkmar, 2005). Currently, there continues to be a debate as to which diagnostic approach has the most empirical support due to limitations and methodological flaws in the research.

PDD-NOS

PDD-NOS is a sub-threshold category for developmental disorders. This category was meant for cases where individuals exhibited some impairment in social learning and reciprocity, but did not have the severity or extent of impairments as those diagnosed with autism. The first category of "PDD" was included in DSM-III, which was later revised in DSM-III-R to be termed "PDD-NOS" (Towbin, 2005). DSM-IV (APA, 1994) described individuals with PDD-NOS as those who fail to meet age criteria, do not exhibit all the elements of autism or other similar disorders, or exhibit symptoms that are not of sufficient severity to meet criteria for autism. The most recent revision of DSM-IV-TR (APA, 2000) clarifies that PDD-NOS is a disorder of reciprocal social interaction displayed by impairments in either verbal, non-verbal, or repetitive behaviors. This clarification precludes a diagnosis of PDD-NOS if a social impairment is not present.

Not long after Kanner (1964) identified autism, there were accounts of cases that were similar to those with autism, but fell short of Kanner's characterization. These cases tended to have an early-onset of symptoms, and impairments in relating to others, but exhibited less

difficulties with language and repetitive behaviors (Bender, 1946; Despert & Sherwin, 1958). Though there is considerable evidence that there are groups of individuals who exhibit some similarities to those with autism who do not meet full criteria, the existence of a diagnostic category for these individuals is often criticized. One such criticism is that the "not otherwise specified" category only complicates the diagnosis of children with such disorders. This category is vague and has little value in communicating the specific strengths and deficits or prognosis of the person with the diagnosis. Others suggest that this category should be considered part of the spectrum of autistic disorders, not a distinct category. Though this appears to be a common statement in the literature, this too creates problems when trying to reconcile it in with the current categorical diagnostic system.

While categorical systems are typically used to facilitate efficient communication among professionals, it requires imposing false categorical distinctions on what may be dimensional variables (Towbin, 2005). One apparent problem with the current diagnostic guidelines is that it does not operationalize how much impairment is necessary or sufficient to meet criteria for ASD (i.e., autism, Asperger's Disorder, PDD-NOS). Further, current diagnostic systems (i.e., Autism Diagnostic Interview-Revised, ADI-R; Autism Diagnostic Observation Schedule-Generic, ADOS-G) do not have an agreed-upon cut-off point to distinguish between all ASD. Therefore, the distinction is made based on clinical experience, training, and clinical judgment of the clinician. Although an experienced clinician can reliably identify an ASD from other non-ASD disorders (kappa of .67, 91% agreement), the reliability in differentiating between ASD is much weaker (kappa of .51, 73% agreement; Mahoney, Szatmari, Maclean, Bryson, Bartolucci, Walter, et al. 1998). Furthermore, out of those diagnoses in the ASD, Mahoney and colleagues (1998) found that the largest number of disagreements involved diagnoses of PDD-NOS.

Given these deficiencies in the current system, it is not surprising that the PDD-NOS category takes on multiple meanings in clinical practice. One such meaning given to PDD-NOS is for use as a default diagnosis when information regarding the developmental history is inadequate. In this view, the PDD-NOS may be used as a temporary designation until clarification is reached. Another use of this category is in the case when some required symptoms are absent, or when symptoms are present, but not severe enough to qualify for autism or Asperger's Disorder (Allen, Steinberg, Dunn, Fein, Feinsten, Waterhous, et al., 2001). A third use of this category is for individuals who have a late onset (i.e., after 30 months of age) of autistic symptoms. Although this is relatively rare, there are reports of individuals who present with symptoms at an older age who do not meet criteria for another diagnosis. Finally, this category may be used for individuals who present with other disorders of social relating that are not well characterized in the current literature and are not recognized by the current diagnostic system (i.e., Multiple Complex Developmental Disorder, MCDD, described by Buitelaar & van der Gaag, 1998; Disorders of Attention, Motor Control, and Perception, DAMP, described by Gillberg, 2003).

Childhood Disintegrative Disorder (CDD)

CDD, a relatively rare disorder, was first reported in 1908 by Theodore Heller. Heller (1908, as cited in Volkmar, Koenig, & State, 2005) described six children who experienced severe regression in development between ages 3 and 4, after a period of normal development. Though now called CDD, Heller originally termed this disorder *dementia infantilis*; CDD has also been previously known as Heller's syndrome and disintegrative psychosis. Over the years, CDD has been confused with childhood schizophrenia, COPDD, and autism (Volkmar, Koenig, & State, 2005). Though this disorder has a long history, CDD was first officially recognized in ICD-10 and DSM-IV.

Children with CDD exhibit similar deficits as children with autism, including problems with social interaction, communication, and restricted interests or patterns of behavior, as well as a loss of interest in the environment. However, what distinguishes CDD from autism is that onset typically occurs at a later age (i.e., between ages 3 and 5) and there is either a gradual (i.e., weeks to months) or abrupt (i.e., days to weeks) loss of skills (i.e., marked deterioration of verbal language, social interaction skills, or deterioration in self-help skills such as toileting) in multiple areas. The children experience limited, if any, recovery after the developmental regression. Further, unusual behaviors are often observed including stereotypies, problems with transitions, and overactivity (Malhotra & Singh, 1993).

Many have debated whether or not this disorder should be distinguished from autism. Volkmar and Cohen (1989) identified 10 cases within larger samples of individuals with ASD, and compared CDD to late-onset cases of autism. These authors found that cases of late-onset autism tended to be higher functioning than those with CDD who were often mute, had greater degrees of ID, and were more likely to require specialized residential placement. In preparation for DSM-IV, 77 cases of CDD were identified in the literature, and 31 cases were identified during the DSM-IV field trials. Of the 77 cases found in the literature, the mean age of onset was 3.4 years. This disorder appears to be more frequently observed in males when compared to females. Moreover, children with CDD have been found to have a higher rate of epilepsy and EEG abnormalities when compared with autistic children (Kurita, Osada, & Miyake, 2004). Due to the rare occurrence or identification (estimated at 1 case per 100,000 children), descriptive information regarding etiology, prevalence, and course is limited and should be taken with caution (Volkmar, Koenig, & State, 2005).

Rett's Disorder

Rett's Disorder was first identified by Andreas Rett of Austria (1966, as cited in Van Acker, Loncola, & Van Acker, 2005) in 22 girls who displayed similar hand mannerisms, dementia, autistic behavior, ataxia, cortical atrophy, and hyperammonemia (i.e., excess of ammonia in the blood; the latter was later found to be only rarely associated with the disorder). Rett originally termed this disorder *cerebroatrophic hyperammonemia*, which received little exposure. Later, Hagberg of Sweden in 1980, unaware of Rett's previous presentation, recognized similarities among 16 of his patients and presented a paper at the European Federation of Child Neurology Societies. This presentation led to a renewed interest in this disorder, which was then given the name Rett's Disorder (Van Acker, Loncoloa, & Van Acker, 2005).

Parents of children with Rett's Disorder most often report an unremarkable prenatal or perinatal history. Excess levels of hand patting, waving, and involuntary finger, hand, and arm movements are the most typical early warning signs of the syndrome. However, these signs are often not recognized as such, and thus frequently parents report normal development up to the first 6 to 8 months of life. Soon after this period of "normal" development, there is a slowing or halting in the acquisition of developmental milestones including speech, skills requiring balance, social interests, and interpersonal skills (Van Acker, Loncola, & Van Acker, 2005). Further, acquired microcephaly (head deceleration), coarse and jerky movements of trunk and limbs, and broad-based gait typically accompany the behavioral deficits. These rapid declines in behavior and ability typically result in severe-to-profound ID and prominent stereotypic movements involving the hands.

A four-stage clinical pattern has been proposed by Hagberg and Witt-Engerstrom (1986). *Stage 1* (onset 6 to 18 months) is marked by a decline in motor development such as difficulties

with crawling, standing, and walking. Hypotonia is common. *Stage 2* (onset 1 to 4 years) is marked by a decline in previously attained skills including social interaction, cognitive abilities, loss of purposeful hand movements, and speech. Stereotypic movements are typical during waking hours; respiratory difficulties including hyperventilation or pauses in breathing are common in this stage. *Stage 3* (onset 2 to 10 years) is marked by improved social interaction. Children appear to be interested in their surroundings and communication skills improve. Seizures often occur during this stage. Movements are jerky, clumsy, and stiff. *Stage 4* (onset 10+ years) involves further progressive muscle wasting, scoliosis, spasticity, rigidity, and decreased mobility. However, cognitive functioning remains stable and social interaction and attentiveness improve. Little is known about the course of this disorder beyond adolescence, as there is a dearth of systematic studies on individuals with this syndrome in this age group. There are a few reports of individuals with this disorder living into their sixties and seventies.

This syndrome almost exclusively occurs in females. There have been a few reports of similar symptoms in males; however, most of these fail to meet criteria of a classic case of Rett's Disorder. This is due to the fact that the syndrome is caused by a mutation on the paternal X chromosome, which would be lethal in males. More recently, a gene was discovered that was involved in the pathogenesis of this disorder (Amir, Van den Veyver, Wan, Tran, Francke, et al., 1999). During typical development, many genes are needed during critical periods of CNS development and/or after birth. Turning these genes on and off is essential for normal development. Mutations in the MECP2 gene result in a failure to produce the MECP2 protein, which plays an important role in "silencing" various genes during CNS development. Thus, these genes continue with further transcription resulting in abnormal development and functioning. Prevalence rates of Rett's Disorder have been reported to occur in 1 out of every 12,000-15,000 births (Hagberg, 1985; Kerr & Stephenson, 1985). As such, it should be considered an important

etiological factor of developmental disabilities in females. It should be noted that there is some debate as to whether Rett's Disorder should be grouped with other ASD in the DSM-IV and ICD-10, as some females with the syndrome do not exhibit autistic-like symptoms (Gillberg & Billstedt, 2000).

ASD Currently Defined

While there have been several descriptions of autism proposed, most notably those of Rutter (1978), Ritvo (1978), and Wing and Gould (1979), Rutter's definition based on the historical accounts of Kanner had more influence over the current diagnostic system put forth by the APA (Volkmar & Klin, 2005). The following is a review of the current DSM-IV-TR and ICD-10 diagnostic criteria for ASD (APA, 2000; WHO, 1992). One distinction between these systems is that the ICD-10 includes one set of research diagnostic criteria and separate set of clinical guidelines, while the DSM-IV-TR does not (Volkmar & Klin, 2005).

According to DSM-IV-TR (APA, 2000), to meet criteria for Autistic Disorder, an individual must exhibit gross impairments in social interaction and communication, and have restricted or repetitive interests or patterns of behavior. These impairments must be characterized by at least six of the following criteria among the three areas of deficits. Further, delays or abnormalities in functioning in at least one area must be noted prior to age 3, which are not better accounted for by Rett's Disorder or CDD.

Socially, the individual must exhibit deficits in at least two of the following four criteria: 1) impairment in the use of nonverbal behaviors such as eye contact, facial expression, body postures, and gestures used in social interaction; 2) an absence of developmentally appropriate peer relationships; 3) a lack of spontaneous sharing of enjoyment, interests, or achievements with others; and, 4) not actively participating socially or engaging with others (i.e., lack of social or emotional reciprocity).

Impairments in communication must be displayed in at least one of the following four criteria: 1) delay in the development of spoken language (i.e., commonly used threshold is spoken words by age 2, and short phrases by age 3); 2) if speech is present, difficulty in initiating or sustaining conversations with others; 3) repetitive, stereotypic or idiosyncratic use of language; and, 4) lack of developmentally-appropriate spontaneous make-believe play or social imitative play.

Restricted, repetitive, and stereotyped behavior must be present and exhibited by at least one of the following four criteria: 1) preoccupation with restricted or stereotyped interest which encompasses a large amount of the individuals' time and is abnormal in intensity or focus; 2) rigid adherence to specific routines or rituals that serve no particular function; 3) repetitive motor gesticulations such as hand or finger flapping, or rocking back and forth; and, 4) continual fixation on parts of objects rather than the whole object or the function of the object.

During the DSM-IV field trial, various approaches to data analyses were utilized. These analyses revealed that there were some items (i.e. items with low base rates or strong developmental associations) included in the ICD-10 (WHO, 1992) that could be eliminated from the definition. Thus, fewer criteria were included in the DSM-IV than the ICD-10 diagnostic criteria for autism (i.e. the following are included in ICD-10 diagnostic criteria, but are not explicitly stated in the DSM-IV criteria: "abnormalities in the intonation, pitch, stress of speech," "distress over small non-functional changes in the environment").

DSM-IV-TR (APA, 2000) defines Asperger's Disorder as a pervasive developmental disorder characterized with qualitative impairments in social interaction (i.e., meets two of the four social impairment criteria of autism listed above) and restricted patterns of behavior or interests (i.e., meets at least one of the four restrictive and repetitive behavior criteria of autism listed above) which result in clinically significant impairment in social or occupational

functioning. Further, to meet criteria for this disorder, the individuals must have no clinically significant delay in language, cognitive abilities, or other age-appropriate self-help skills, adaptive behavior (other than social behavior), or curiosity about their surroundings. Lastly, the individual must not meet criteria for another ASD. While the ICD-10 (WHO, 1992) refers to this disorder as Asperger's Disorder, conceptually the definitions in DSM-IV and ICD-10 are equivalent (Klin, McPartland, & Volkmar, 2005; Leekam, Libby, Wing, Gould, & Gillberg, 2000; WHO, 1992).

PDD-NOS is defined by the DSM-IV-TR (APA, 2000) as a diagnosis to be used when there are severe and pervasive impairments in reciprocal social interaction that is either manifested in verbal or nonverbal communication deficits or by the presence of stereotyped patterns of behavior, interest, or activities, but the individual does not meet criteria for another ASD. This diagnostic category is to be used when criteria are not met due to a late onset of symptoms (after age 3), atypical symptom presentation, and/or when symptoms are not sufficiently severe to warrant a more specific diagnosis. Further, criteria should not also be met for Schizophrenia, Schizotypal Personality Disorder or Avoidant Personality Disorder if this diagnosis is to be given. The definition of PDD-NOS as described by the APA is broader than that defined by the WHO. The ICD-10 has two categories for cases that would be labeled PDD-NOS when using the DSM-IV. ICD-10 has one category for "atypical autism," which is used for cases with late symptom onset or when there is a lack of sufficient criteria to meet a diagnosis for autism, and a separate category for "PDD, unspecified" (WHO, 1992).

CDD is described in the DSM-IV-TR as a marked regression in the maintenance of previously acquired skills in at least two areas of functioning after a period of typical development for at least 2 years (i.e., after age 2). Clinically significant loss in skills should be noted in at least two of the following areas before age 10: expressive or receptive language,

social skills or adaptive behavior, bowel or bladder control, play, or motor skills. Further, there should be abnormalities in functioning noted in at least two of the following areas: 1) impairments in the quality of social interaction with others; 2) impairments in the quality of communication; and 3) restrictive, repetitive, and stereotyped patterns of behavior or interest. Moreover, these symptoms should not be better accounted for by another specific ASD or Schizophrenia (APA, 2000). Overall, DSM-IV-TR has a less detailed symptom description than the ICD-10; ICD-10 includes a disinterest in the environment in the diagnostic criteria, whereas the DSM-IV-TR does not include this criterion.

Similar to CDD, Rett's Disorder is described by DSM-IV-TR as a disorder in which there is a loss of skills after a period of normal prenatal and perinatal development, head circumference at birth, and psychomotor development through the first 5 months of life. However, between the ages of 5 to 48 months, there is a deceleration of the head growth, loss of previously acquired hand skills and increases in stereotyped hand movements (e.g., hand wringing), loss of social engagement, development of a poorly coordinated gait and trunk movements, and increased impairment in expressive and receptive language development with severe psychomotor retardation (APA, 2000). There is no distinction between the criteria for Rett's Disorder in ICD-10 and DSM-IV-TR (WHO, 1992).

As the prevalence, etiology, and course of CDD and Rett's Disorder have already been briefly discussed in the above sections, which highlighted the limited information available on these disorders, the remaining sections will focus on the more commonly occurring and closely related ASD in children (i.e., autism, Asperger's Disorder, and PDD-NOS).

Prevalence of ASD

Autism was once described as a rare condition (i.e., 3.9 per 10,000); however, more recent studies have suggested much higher estimates of this developmental disorder. Average

estimates of autism range from a minimum rate of 20.5 to 38.9 per 10,000, and for the broader spectrum of all ASD with estimates ranging from 53.3 to 116.1 per 10,000 (Baird, Simonoff, Pickles, Chandler, Loucas, Meldrum, & Charman, 2006; Gillberg, Cederlund, Lamberg, & Zeijlon, 2006). Furthermore, annual reported rates of ASD suggest that the incidence (i.e., number of individuals in which the onset of the condition occurs within a certain period of time) and prevalence (i.e., number of individuals who have the condition within a certain period of time) estimates of this disorder are increasing (Wing & Potter, 2002). Wing and Potter (2002) proposed several reasons for these findings: 1) changes in diagnostic criteria; 2) variability across studies in the methods used to diagnose; 3) increased awareness of ASD among professionals and parents; 4) recognition that ASD can occur in persons with ID, average IQ, or above-average IQ; physical disability; or psychiatric disorder; 5) increased development of specialized services for ASD; and 6) possible true increases in number.

As discussed previously, there have been many changes to the DSM-IV and ICD criteria for autism and related disorders since the autism was first introduced by Kanner in 1943 and later officially recognized in the DSM-III in the 1980s. Moreover, people now considered to have ASD are a much broader group than what was originally described in 1943. It was not until the DSM-III-R that it was accepted that persons with autism may have the triad of deficits with varying degrees of severity. With each revision of the DSM, new subgroups of this spectrum were recognized. Over the years, there have been many suggestions and modifications of the diagnostic criteria for these disorders. Given this evolving conceptualization of ASD, it is not surprising that various criteria were used by different prevalence researchers over the years. Further, as there are no definitive diagnostic tests for autism (i.e., diagnosis is based on developmental history and behavioral observations), there is still some disagreement over which diagnostic systems or symptom severity thresholds warrant a diagnosis of autism or other ASD.

Therefore, the lack of standardized criteria and overall more-inclusive conceptualization of disorders over time is one possible reason for the rise in rates (Wing & Potter, 2002). It should be noted that it is unlikely that this is the only reason, due to the fact that DSM-III criteria were found to be over-inclusive when compared to DSM-IV and ICD-10 (Volkmar, Cicchetti, & Bregman, 1992; Volkmar & Klin, 2005).

The differences in the methods used to examine rates and identify cases also may have contributed to this increasing trend. Some suggest that differences in the size of the target populations, proportion of immigrants, and the methods of identifying cases across studies impact the change in rates over time. Higher rates have been found in studies employing smaller target populations, methods that involve routine developmental checks for preschool-aged children, and samples including more immigrants (Wing & Potter, 2002; Fombonne, 2003a).

Furthermore, since the development of parent and professional groups advocating for this population in the 1960s, there was general increase in awareness among parents and professionals about ASD. The push for educational and treatment services by advocating groups fostered professional interest and research in this area, which in turn advanced the methods by which clinicians diagnose these disorders and the treatment services available to children. More recent concerns regarding causes of autism (i.e. measles, mumps, and rubella [MMR] vaccination, which will be discussed in more detail later) have again increased the public's awareness of this condition.

Through the years, professionals have come to the understanding that autism occurs with comorbid conditions. Though Kanner first believed that autism occurred in children with normal intelligence, it was later found that autism and ID frequently co-occurred (approximately 50 to 70% with ID; Baird, Simonoff, et al., 2006). As a result, many people who were then classified as having severe or profound ID may now be classified as autistic by current diagnostic criteria.

Moreover, it is now also recognized that ASD occur in children with above-average IQ (i.e., often classified as Asperger's Disorder); however, the work of Asperger was not well known among English-speakers until the 1970s and 80s. It has also recently been noted that other Axis I conditions such as ADHD, depression, phobias, and other anxiety disorders occur in children with autism (Davis, Kurtz, Gardner, & Carmen, in press; Ghaziuddin, Tsai, & Ghaziuddin, 1992; Ghaziuddin, Weidmer-Mikhai, & Ghaziuddin, 1998; Matson & Love, 1990; Woodard, Groden, Goodwin, Shanower, & Bianco, 2005). Perhaps more notable is that, for some children of average to above-average IQ, these comorbid symptoms oftentimes overshadow the presence of an ASD.

The availability of specialized services for children and families of children with ASD has coincided with the increase in prevalence rates. These services include the recognition of autism in the Individuals with Disabilities Education Act (IDEA) in 1991. As treatment, support, and educational services increased, parents may be more willing to consider the possibility of an ASD diagnosis and more willing to accept such a diagnosis. Also, professionals may be more likely to make the diagnosis if appropriate services are available and offered to those with a diagnosis (Wing & Potter, 2002). Wing and Potter's (2002) review of prevalent studies over time suggest that most of the reported increases in rates are likely due to a combination of changes in the diagnostic criteria and greater public awareness of these disorders. While these investigators do not deny the possibility that there is an actual rise in the prevalence of ASD, they indicate that no definitive answer is currently available due to inconsistencies in the methodologies employed in past research. Future research is needed to adequately address this possibility.

Gillberg and colleagues (2006) conducted a recent investigation evaluating the prevalence of autism in an urban area in Sweden from 1977 to 1994. These researchers found

that out of a total of 102,485 individuals born during this time period and who lived in Göteborg, Sweden, at the time of the study, 3,460 were evaluated at a diagnostic clinic for ASD. Of these evaluations, 546 resulted in an ASD diagnosis and a global assessment of functioning below 70, indicating need of support services. The population prevalence of any ASD over the 18-year period was 0.53 %. When this prevalence rate was evaluated in three cohorts, the researchers found a statistically significant increase in the prevalence rate over time, with a rate of 0.26% for those born 1977 through 1982, 0.61% for those born from 1983 through 1988, and 0.80% in those born from 1989 through 1994.

Of the total 546 evaluations, 210 (38%) qualified for a diagnosis of autism, 94 (17%) qualified for a diagnosis of Asperger's Disorder, 2 (0.4%) qualified for a diagnosis of CDD, and 241 (44%) qualified for a diagnosis of PDD-NOS. Among these cases of ASD, males had a higher prevalence rate than females. This is consistent with previous reports, including Fombonne (2003a, 2003b) who reported a higher rate of males diagnosed with ASD (mean rate of 4.3 males: 1 female). Further, for higher functioning autism or Asperger's Disorder, the male to female ratio is even higher (5.8 males: 1 female). Overall, Gillberg et al. (2006) found that there were higher rates in males than in females for autism (2.8 males: 1 female), Asperger's Disorder (10.8 males: 1 female), and PDD (3.4 males: 1 female), but for CDD there was one male and one female. Though it remains unclear the precise reason for the increase in prevalence rate over time, these authors suggest that it is likely due to the broadening of diagnostic criteria, and better services for diagnosis. Moreover, it is apparent that there is an increase in the service needs for this population (Baird, Simonoff, et al., 2006).

Etiology

Along with the increased availability of services for this population, there has been a surge of research examining the possible causes of autism and related disorders. Over the years a

number of hypotheses have been put forward to explain why this group of disorders occurs, many of which have been quite controversial. Explanations involving genetic factors are among those with the most empirical support, while other hypotheses (i.e., MMR vaccine) have little empirical basis (Matson & Minshawi, 2006). A brief description of the primary etiological theories will be reviewed.

Although Kanner originally believed autism to be a disorder with a biological basis, he did discuss the relationship problems he observed between the children and their parents. As a result, many professionals focused their attention to this parent-child relationship. In the 1950s, with the influence of the psychodyndamic theories of the era, many professionals adopted the theory that autism was a result of cold and un-nurturing parenting. Eveloff (1960, p. 90), in his case studies, described parents of children with autism as "successful autistic adults." He suggested that the parenting of mothers who were cold, impersonal, and ritualistic, and fathers who were detached and perfectionistic was part of the etiology of this childhood disturbance. Soon after, Bettelheim (1967) proposed that mothers who were cold and unloving, who he termed "refrigerator mothers," were responsible for raising children with severe developmental and social deficits. Unfortunately, although these theories were later diminished, parents of children with autism have carried a significant burden left from this unfounded theory (Matson & Minshawi, 2006). With the shift to empirical-based theories and the rise of behaviorism, psychodynamic theories of ASD were soon replaced with theories based on genetic, neurobiological, and learning factors.

Genetic Factors

Theories regarding the genetic factors of ASD were initially given little credibility because 1) children with ASD rarely had parents with ASD; 2) no chromosomal anomaly could be identified as a marker for ASD; and 3) estimated rates of ASD among siblings were initially

low (Rutter, 1968). However, more recent research examining the rate of ASD among twins suggests a much higher concordance than was initially noted. Research by Folstein and Rutter (1977) which examined 11 pairs of monozygotic and 10 pairs of dizygotic twins, found a 36% pair-wise concordance rate for ASD in the monozygotic twins and a 0% rate in the dizygotic twins. However, the concordance rate of monozygotic twins increased to 82% when the data were reanalyzed to include higher functioning, yet socially impaired relatives (Folstein & Rutter, 1987). Similarly, Ritvo, Freeman, Mason-Brothers, Mo, and Ritvo (1985), who studied 23 pairs of monozygotic and 17 pairs of dizygotic twins, found a 95.7% concordance rate of ASD among monozygotic twins and only 23.5% concordance rate among dizygotic twins. Given the current estimated prevalence rates of ASD (i.e., estimates of 53 or greater per 10,000), this data suggest that concordance of ASD in twins is greater than chance. While these studies did have some methodological problems (such as lack of random sampling), subsequent studies have confirmed these early twin studies. Bailey et al. (1995), in their British twin study with 45 twin pairs, found a 60% concordance rate among monozygotic twins and a 0% concordance rate among dizygotic twins. Further, 92% of the monozygotic twins were found to share a mixture of social and cognitive deficits related to a broader phenotype of ASD.

Family studies, which look at the rates of ASD among non-twin siblings and the offspring of individuals with ASD, have also lent support to the genetic basis of these related disorders. While the outcomes of family studies may be influenced by a number of factors (i.e., environmental), they do provide additional data to consider. The reported rate of ASD among siblings is approximately 3%; however, some reported rates are as high as 5.9% (August, Stewart, & Tsai, 1981; Bolton et al., 1994; Baird & August, 1985). Again, when considering the prevalence rate of autism, these studies suggest a much higher rate in siblings. Ritvo, Jorde, and Mason-Brothers (1989), in their epidemiologic survey, reported an 8.6% risk of autism for

siblings. Taken together, this data lends some support for a genetic component of ASD (Matson & Minshawi, 2006).

A third source of data to support a genetic basis of autism is the association with particular disorders of known genetic etiology (Browndyke, 2002). Fragile X is a cytogenetic marker associated with Fragile X Syndrome. This syndrome is the second most common cause of ID and is associated with autism (Gillberg & Coleman, 1996). Ritvo, Jorde, and Mason-Brothers (1989) reported that of 614 males screened in 12 studies, 7.7% were identified with the marker. Other genetic disorders associated with ASD include tuberous sclerosis, untreated phenylketonuria, and neurofibromatosis (Gillberg & Coleman, 1996). However, it should be noted that the great majority of cases of autism are of unknown etiology (Browndyke, 2002).

The genetic basis of ASD has received increased attention over the recent years. While it does not appear that a single gene is responsible for the deficits found in ASD, some researchers have suggested that there may be multiple genes involved, thus explaining the heterogeneity of symptoms found in individuals with ASD (Bailey et al., 1995). Though the nature of this genetic component is not yet fully understood, there is strong evidence for a genetic etiologic component of ASD.

Neurobiological Factors

Another etiological basis for ASD suggested by researchers is neurobiological factors. As the majority of those with ASD function within the range of ID, factors contributing to an underlying neurological or biological abnormality should be considered as causal mechanisms (Matson & Minshawi, 2006). Several neurological abnormalities have been reported in children with ASD, including clumsiness, gait disturbances, tremors, sensory sensitivity, and epilepsy (Bryson & Smith, 1998; Kawasaki, Yokota, Shinomiya, Shimizu, & Niwa, 1997; Powers & Poland, 2003; Tsai, 1999b). Though epilepsy occurs in approximately 30% of those with ASD,

no specific electrical activity has been found to be associated with ASD. Despite these common co-occurrences, the exact causes of these neurological abnormalities in the ASD have not been identified. As there are a variety of aberrant behaviors associated with ASD, multiple areas of the brain have been suggested as the loci of brain dysfunction. Areas of structural and functional pathology associated with autism include the limbic system, basal ganglia, vestibular system, and cerebellum. Of the studies conducted so far, pathology related to the cerebellum and the limbic system have the most support; however, more research is needed before strong conclusions can be drawn (Browndyke, 2002).

In addition to these common abnormalities, neurochemical abnormalities have been reported in those with ASD. Tsai (1999) indicated that due to the lack of identifiable brain pathology in this population, research then began to focus on possible abnormalities in neurochemistry. Much of this research focused on the effects of psychotropic medications as treatment for symptoms of ASD.

Serotonin is the most widely studied neurotransmitters in the ASD literature (Matson & Minshawi, 2006). This neurotransmitter is involved in a number of vital activities including eating, sleeping, sexual activity, and mood regulation (Lam, Aman, & Arnold, 2006). Many of these studies have focused on the level of serotonin in the bloodstream (Anderson & Hoshino, 2005). Increased levels have been found in samples of individuals with autism (i.e., 17% to 128% higher than controls). However, the reason for these increased levels remains unclear as the storage of serotonin in this population appears to be normal.

Endogenous opioids, which primarily affect the central nervous system, are another neurotransmitter group that has received some attention in the literature (Matson & Minshawi, 2006). Behavioral symptoms found in this population, such as stereotyped behaviors or insensitivity to pain, have been associated with opioids (Lam, Aman, & Arnold, 2006). Several

studies have suggested elevated levels of endogenous opioids in samples of children with ASD (e.g., Gillberg, Terenius, & Lonnerholm, 1985; Ross, Klykylo, & Hitzmann, 1985; Sandmann, Barron, Chizcdemet, & Demet, 1991). Elevated opioids have been suggested to interfere with the development of social and emotional development, in addition to deficits in attention and sensory modulation (Sahley & Panksepp, 1987; Sandyk & Gillman, 1986). More research is needed to further investigate this possibility.

MMR Vaccine

During the 1990s, a study conducted by Wakefiled et al. (1998) in England put forth the hypothesis that autism was a result of an environmental insult related to the administration of the measles, mumps, and rubella (MMR) immunizations. The purpose of the study was to evaluate the relationship between gastrointestinal problems and ASD in 12 children who had a history of intestinal problems. In 8 of the 12 children, onset of behavior problems was temporally related to the MMR vaccination. Wakefield et al. (1998) suggested the hypothesis that the MMR vaccine led to inflamed or dysfunctional intestines which increased the permeability of the intestines, allowing for excessive absorption of gut-derived peptides. These peptides were suggested to have opioid effects on the central nervous system and brain development, which in turn was related to autistic behaviors. These researchers suggested that the MMR vaccine was responsible for the increased incident rates of ASD. While this hypothesis did gain momentum in the media due to increases in incident rates of ASD that coincided with the introduction of MMR vaccine, studies further evaluating this hypothesis have failed to support this conclusion (Matson & Minshawi, 2006; Rutter, 2005).

Recent studies evaluating the increase in rates of ASD do not follow a pattern that would implicate the MMR vaccinations as a causal effect. First, the beginning rise in incidents began before the introduction of the MMR vaccine. Second, there were no step-wise increases when the

vaccination was first introduced. Third, the rate of ASD did not plateau during the period when the MMR vaccinations were stable (Rutter, 2005). Moreover, the termination of the vaccination in Japan in 1993 due to a suspected side effect did not lead to a decline in the frequency of ASD. In Japan, the seven year cumulative incidence (1988 to 1996) rose progressively from 47.6 per 10,000 to 117.2 per 10,000. This rise in rates was observed in cohorts of children born when the MMR vaccine was withdrawn, which suggested that the timing of the introduction of the MMR and the increased rates of ASD noted in the United Kingdom and the United States were coincidental in nature (Honda, Shimizu, & Rutter, 2005).

Learning Factors

Ferster (1961) is credited with the first attempt to understand the behavioral theory of etiology for ASD. According to his theory, symptoms of ASD were the result of a failure of social stimuli (e.g., praise, attention) to gain the reinforcing properties to control behavior. Ferster and DeMeyer (1961) demonstrated that the behavior of children with ASD could be controlled by environmental stimuli, mainly primary reinforcers (i.e., food), and thus demonstrated that these children could learn.

Lovaas and Smith (1989) furthered our understanding of children with ASD. They observed that children with ASD were a diverse group. Their theory comprised four basic tenets. First, these researchers proposed that the laws of learning theory accounted for the behaviors observed in children with ASD and provided a basis for treatment. Second, they believed behaviors observed in this population are developmental delays, not a problem that will be completely corrected with treatment. Third, they suggested children with ASD can learn when given an appropriate environment in which to do so. Finally, this theory emphasized both environmental and individual variables, such that when the environment is appropriately arranged, the child with ASD has the capacity to learn and be successful. Differing from other

etiological models, behavioral theories focus on specific behaviors that constitute autism, rather than ASD as a construct. Therefore, behavioral therapy focuses on the individual behaviors of the person and the environment in which the person exists, rather than the etiology of the behaviors. Thus, behavioral views of autism is quite different than those previously discussed.

While there has been much progress in the way of research on the etiological models of autism, no single cause has been identified. Despite the evidence supporting genetic, neurobiological, and learning factors contributing to the existence of this disorder, it is likely that a combination of factors cause ASD.

Assessment

As early intervention has been shown to greatly impact the outcomes of children with ASD, early and accurate identification of these disorders is crucial (Ben-Itchak & Zachor, 2007; Matson, 2007 a). Assessments for ASD typically involve clinical observations of the child, parent/caregiver and sometime child interviews, and the completion of behavioral checklists or questionnaires (Matson, 2007 b). Though there are a variety of assessment instruments available for autism, fewer are available for Asperger's Disorders, and less is available for PDD-NOS. The most commonly noted assessment instruments available for ASD are briefly discussed below.

Assessing Autism

Most of the assessment instruments developed for ASD have focused on autism. Several measures have empirical support and sound psychometric properties. Overall, assessments (including checklists, interviews, and observation systems) for autism tend to be more extensively developed and cited in the literature when compared to measures designed to assess for another ASD. These assessments most frequently focus on the early school age period (ages 4-5); however, a few other assessments have been developed with the aim of identifying children with autism at a much younger age (i.e., 18 months; Matson, 2007 b).

Childhood Autism Rating Scale (CARS). The CARS (Schopler, Reichler, & Renner, 1988) was developed in North Carolina to assist in screening children for autism in a state-wide educational program (TEACCH). The CARS was developed based on DSM-III. It consists of 15 subscales that are rated on 1 (normal) to 4 (severely abnormal) point scale. The subscales assess impairments and aspects of behavior that are frequently noted in children with autism, such as verbal communication, sensitivity to sounds, and repetitive and imitation skills. Total scores range from 15 to 60, where a score of 30 to 36.5 suggests a mild autistic behavior, and a score of 37 to 60 suggests severe autism.

This scale can be completed by integrating information from parent or teacher interviews and clinical observations. The initial data collected for the preliminary evaluation of the psychometric properties were collected on 537 children enrolled in the TEACCH program over a 10-year period. Initial evaluations of scale reliability (inter-rater reliability of most items above .50; inter-rater total score reliability ranging from .68 to .80; and internal consistency ranging from .73 to .94) and validity (agreement with clinical diagnosis kappa correlations ranging from .63 to .64 for children aged 2 to 3 years) were good, which elevated this scale to national and international recognition as a means of detecting autism in children (Stone et al., 1999).

Though this is a widely recognized assessment instrument for this population, several weaknesses have been noted. First, the CARS is based on the DSM-III-R; it does not conform to DSM-IV-TR criteria and thus, is in need of a revision (Lord & Corsello, 2005; Matson, 2007 b). Second, it frequently overestimates the number of autistic symptoms in children with severe forms of ID (Pilowsky, Yirmiya, Shulman, & Dover, 1998; Van Bourgondien, Marcus, & Schopler, 1992). Third, it does not provide a means of differentially diagnosing autism from other ASD (Klinger & Renner, 2000; Matson, 2007 b).

Autism Behavior Checklist (ABC). The ABC (Krug, Arick, & Almond, 1979) was developed to aid in classroom placement in educational settings. It was designed for teachers with minimal expertise with autism to rate the behavior of the child in question. This checklist consists of five subscales pertaining to sensory, relating, body and object use, language, and social and self-help aspects of behavior. There are 57 items, which are rated on a scale of 1 to 4, and the checklist takes approximately 10 to 20 minutes to complete. Scores of 67 or above reflect a high probability of autism, while scores of 53 or below indicate a low probability of autism (scores between 53 and 67 indicate an unclear probability of autism and warrant further evaluation). Initial psychometric properties were developed from the data of 42 independent raters of 14 children. Estimates of reliability have been reported, with adequate inter-rater (kappa greater than .40) for most items and internal consistency (alpha) for the total score of .87, while item internal consistency ranged from .38 to .87 (Coonrod & Stone, 2005). However, subsequent evaluations have not shown such promising statistical properties. Like the CARS, the ABC is not based on current DSM-IV criteria. Further, it does not offer information regarding differential diagnosis of other ASD.

Autism Diagnostic Interview-Revised (ADI-R). The ADI-R (Lord, Rutter, & LeCouteur, 1994) is the most recent revision of the ADI, which was originally developed in the late 1980s. This semi-structured interview assesses the triad of impairments associated with ASD, communication, social interaction, and repetitive, stereotyped behaviors. This interview, conducted by a person with training and experience in the area of ASD, lasts approximately 2 hours and consists of 93 items. The interviewer scores the caregivers' responses on a scale of 0 (normal behavior or development) to 2 (atypical behavior/development, or impairment). This interview is based on DSM-IV and ICD-10 criteria. Scores are then converted into a diagnostic algorithm to determine if criteria are met for autism. However, it does not provide an algorithm

to differentially diagnose Asperger's Disorder or PDD-NOS. Psychometrics are generally good, with good item and subscale inter-rater reliability, good test-retest reliability, and high internal consistency of subscales. It has been found to adequately converge with the CARS and the Autism Diagnostic Observation Schedule (ADOS) and has been shown to have good construct validity for DSM-IV and ICD-10 (Lord & Corsello, 2005).

Autism Diagnostic Observation Schedule-Generic (ADOS-G). Unlike the previously mentioned checklists and interview schedules, the ADOS-G (Lord, et al., 2000) is a semi-structured observation schedule designed to aid clinicians in diagnosing autism and provides a measure of current functioning. The ADOS-G is the revision of two measures: the original ADOS (Lord, et al., 1989), and the Pre-Linguistic Autism Diagnostic Observation Scale (DiLavore, Lord & Rutter, 1995). The ADOS-G differs from its predecessors in that it consists of four modules (i.e., module 1: preverbal/single words; module 2: flex phrase speech; module 3: fluent speech child/adolescent; and, module 4: fluent speech adolescent/adult) appropriate for children and adults at different levels of development and language ability. The use of different modules is intended to minimize over-diagnosis on the basis of limited language abilities by the examiner by using the modules that best match the expressive ability of the individual being evaluated. The authors report that the modules take approximately 30 minutes to administer. Additionally, the ADOS-G also includes diagnostic algorithms for PDD-NOS. However, there are currently no algorithms available for others disorders in the spectrum like Asperger's disorder. Items are scored on a 3-point scale from 0 (no evidence of abnormality) to 2 (definite evidence). Adequate reliability estimates for inter-rater reliability, test-retest, and internal consistency have been reported by the authors (Lord et al, 2000). The ADOS-G has been found to have good construct validity with DSM-IV and convergent validity with the ADI-R (Lord & Corsello, 2005).

More recently, there is a trend to develop measures that identify autism at an early age. While early identification is important for early intervention for ASD, there is an ongoing debate about whether these disorders can be accurately identified prior to age 3 (Matson, 2007 b). Two such measures are the Checklist for Autism in Toddlers (CHAT) and the Screening Tool for Autism in Two-year-olds (STAT).

Checklist for Autism in Toddlers (CHAT). The CHAT (Baron-Cohen, Allen, & Gillberg, 1992) was designed to be used by pediatricians to identify autism in children during their 18-month checkup. The CHAT is divided into two sections. One section consists of questions for parents regarding the child's social behaviors, imaginative skills, and non-verbal communications (i.e., pointing). The other section consist of observations made during the medical visits including observing the child's eye contact, ability to gesture, read non-verbal communications of others, pretend play, and fine motor skills. The initial study of this measure was completed on 50 children and 41 of their siblings. Of these child participants, only four were autistic (diagnosis confirmed at 30 months; Baron-Cohen, Allen, & Gillberg, 1992). Later studies by Baron-Cohen, Cox, Baird, Swettenham, and Nighingale (1996) involving 16,235 children at 18-months of age identified 10 possible cases of autism. Baird et al. (2000) conducted a 6-year follow-up on these cases and found the CHAT to have poor predictive validity when used with children of 18-months. However, Scambler, Rogers, and Wehner (2001) and Scambler, Hepburn, and Rogers (2006) evaluated the use of the CHAT with 2- and 3-year-olds. These researchers found the CHAT to have a much better predictive validity when used with older children. Overall, more research is needed to evaluate the reliability and validity of this measure.

Screening Tool for Autism in Two-year-olds (STAT). Stone and Ousley (1997) developed the STAT to identify autism in children aged 2 to 3 years. The STAT is an empirically derived measure designed for use by healthcare professionals as a brief measure to identify

children in need of more extensive evaluation and follow-up. It consists of 12 items administered in a play-like interaction, and takes less than 20 minutes to administer. Stone, Coonrod, and Ousley (2000) presented preliminary data that were collected by assessing 40 developmentally delayed children identified to be autistic. These authors reported acceptable levels of sensitivity (.83) and specificity (.86). With a sample of 104 children, Stone, Coonrod, Turner, and Pozdol (2004) found the STAT to have good inter-observer agreement (r=1.00), test-retest reliability (r=.90), and high agreement (r = .95) with the classifications based on the ADOS-G.

Assessing Asperger's Disorder

Unlike the variety of well-developed instruments for identifying autism, there are fewer instruments designed for Asperger's Disorder. Moreover, those that are available are less extensively developed largely due to debates regarding appropriate diagnostic criteria and difficulties in differentiating it from autism (Matson, in press a). The Asperger's Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI; Gillberg, Gillberg, Rastam, &Wentz, 2001*)* is designed to aid in diagnosis for autism and Asperger's Disorder for individuals with adequate verbal skills. This structured interview consists of 20 items assessing areas of social, interests, routines, verbal and speech, communication, and motor behaviors that are based on Gillberg's criteria of Asperger's Disorder. Initial reports of reliability were based on a sample of 20 individuals aged 6 to 55. Inter-rater (kappa = .91) and test-retest (kappa = .92) reliability estimates were excellent. Further research is needed to examine the reliability and validity of this measure with a larger sample of individuals.

Campbell (2005) reviewed the several informant-based instruments available for assessing symptoms of Asperger's Disorder, including the Asperger's Syndrome Diagnostic Scale (ASDS; Myles, Bock, & Simpson, 2001); the Autism Spectrum Screening Questions (ASSQ; Ehlers, Gillberg, & Wing, 1999); the Childhood Asperger's Syndrome Test (CAST;

Scott, Baron-Cohen, Bolton, & Brayne, 2002); the Gilliam Asperger's Disorder Scale (GADS, Gilliam, 2001); and the Krug Asperger's Disorder Index (KADI; Krug & Arick, 2003). Though these informant-based instruments are available, the psychometric data is limited. Campbell (2005) noted significant weaknesses with these measures, similar to the above noted weaknesses of the ASDI, specifically with reference to the incomplete psychometric data and small sample sizes.

Assessing the Spectrum

To the knowledge of the author, there are only a few scales that have been developed to assess the full spectrum of ASD. These include the Diagnostic Interview for Social and Communication Disorders - version 10 (DISCO-10) and the PDD Behavior Inventory. The DISCO-10 is a semi-structured interview schedule designed to assist clinicians in systematically obtaining information relevant to diagnosis, differential diagnosis, and management of autistic and related behaviors (Wing, Leekam, Libby, Gould, & Lercombe, 2002). The DISCO incorporates relevant items for diagnostic criteria for ASD including the triad of impairments. It also includes items relevant to adaptive behavior domains and behaviors that are associated with autism, but not part of diagnostic criteria (i.e., emotional disturbances, problems of attention, or challenging behavior). The DISCO includes three sets of standard algorithms based on DSM-III-R, DSM-IV, and ICD-10. Psychometric properties were evaluated with a sample of 82 parents of children aged 3 to approximately 12 years with either an ASD (36), learning disability (17), specific language disorder (14), or were typically developing (15). When the DISCO was rated by two independent researchers, the reliability was reported to be high, kappa agreement greater than .75 for 397 of the total 466 items for school-aged children, and for 350 out of 412 for pre-school aged children (Wing, et al., 2002). However, no information regarding the agreement of

two different informants is available. Further, no information regarding test-retest reliability has been reported to date.

Cohen, Schmidt-Lackner, Romanczyk, and Sudhlater (2003) developed the PDD Behavior Inventory. The PDD Behavior Inventory is an informant-based rating scale to be completed by parents or teachers, which covers aspects of autism, Asperger's Disorder, PDD-NOS, and CDD. The primary aim of this scale is to assess changes in adaptive and challenging behaviors over time, rather than a measure of differential diagnosis. This inventory was designed for children ages 1.5 to 12.5 years and is based on DSM-IV criteria. The advantage of this measure over other forms of assessment is its brief administration (30 to 45 minutes) and larger standardization sample (369 parents and 277 teachers) when compared to other measures of ASD. Cohen et al. (2003) reported good internal consistency reliability (ranging from .73 to .97 and .79 to .97) for parent and teacher ratings. Inter-rater agreement between parent-teachers was lower (ranging from r = .28 to.85) than between teacher-teacher ratings (ranging from r =.61 to .93). Further, these authors examined the developmental progression across age groups. As predicted, older children with ASD showed more social and verbal skills than younger children in the sample. Moreover, aberrant social and language skills increased with age. Confirmatory factor analysis indicated good construct validity for 7 out of the 10 subscales. In his study examining criterion-related validity, Cohen (2003) reported good correlations with the ADI-R, the CARS, and the Vineland Adaptive Behavior Scales (for adaptive subscales).

Though there are a variety of different assessment instruments available for this population, very few adequately assess the broader spectrum of the ASD. Further, many of these have significant limitations in regards to efficiency, psychometric properties, and normative samples. As early identification and intervention is important for treatment outcome, efficient

and psychometrically sound assessment instruments are needed for the full spectrum of disorders (Matson, 2007 b).

Differential Diagnosis

Intellectual Disability (ID)

Though ID commonly occurs in children with autism, these disorders are distinguished by the distribution of deficits across areas of functioning. Unlike children with only ID who typically have deficits evenly distributed across all areas of functioning, children with autism most often have an uneven distribution of deficits. For children with ID, development of language and responses to sensory and social stimuli are appropriate to their overall level of functioning. Children with autism typically have particular deficits that involve language, social interactions, and repetitive behaviors or interest that are incongruent (more severe) with their overall level of functioning (Ritvo, 1978; Rutter; 1978a). This distinction can be found in some of the most frequently used assessments for autism (e.g., Childhood Autism Rating Scale; Schopler, Reichler, & Renner, 1988).

While social impairments are associated with ID and autism, Wing and Gould (1979) suggest that social impairments should be evaluated in terms of the child's language development and developmental level. These authors found that children with severe ID without autism had symbolic pretend play, and repetitive activities were part of a much wider behavioral repertoire, which was not noted in children with autism.

Communication Disorders

Comparative studies between children with autism and children with developmental communication disorders suggest marked differences (Rutter, 1978c). Bishop and Norbury (2002) found that children with communication disorders (specific language impairments) tended to be sociable children who used both verbal and nonverbal means of communicating, some of

which used stereotypic language and had abnormal intonation, but did not show nonverbal repetitive behaviors characteristic of autism. Though the differences between ASD and communication disorders are not always clearly defined and may lie on a continuum of impairments, the distinction between these disorders should be based on the whole picture of the child, not based on specific symptoms. If the triad of impairments is present, a diagnosis of ASD is warranted; conversely if stereotypic or odd language is present without additional impairments of social interaction a diagnosis of ASD would not be warranted (Bishop & Norbury, 2002).

Childhood Schizophrenia

Early distinctions between autism and schizophrenia were made on the basis on the onset of symptoms, pattern and course of symptoms over time, and family genetics (Evloff, 1960; Romanczyk, Lockshin, & Harrison, 1993). Onset of symptoms in childhood schizophrenia is typically much later than the onset of symptoms of ASD. That said, some investigations examining the clinical histories of children diagnosed with schizophrenia, found that many (i.e., ranging from 17 to 39%) had symptoms that would be sufficient to meet criteria for autism before 30 months (Alaghband-Rad et al., 1995; Watkins, Asarnow, & Tanguay, 1988). These findings indicate that more research is needed to determine if these percentages hold in other samples of persons with schizophrenia, and, if so, what are the implications for accurate diagnosis and the co-occurrence of these disorders.

Social Phobia

The onset of social phobias is typically during the teenage years; however, there are some cases of childhood onset (Manuzza et al., 1995). By taking a complete developmental and behavioral history, a differential between ASD and social phobia can be made. Though children with social phobia are likely to have extreme shyness or avoidance, this is not typically seen across all settings (i.e., children with social phobia typically have appropriate social relationships

with family and close friends). Further, a child with social phobia will experience loneliness and enjoys being with others; this is less frequently seen in those with ASD. Moreover, children with social phobia typically are able to understand complex interactions and the emotions of others, whereas those with ASD most often exhibit deficits in this area (Towbin, 2005).

Obsessive Compulsive Disorder (OCD)

It is not uncommon for stereotyped behaviors seen in ASD to conceptualize as obsessions or compulsions as seen in OCD. However, obsessions associated with ASD tend to be associated with pleasure, while obsessions in the context of OCD tend to be associated with anxiety or unpleasant thoughts. Attempts to distinguish these disorders most often suggest that there are a constellation of additional symptoms more closely associated with ASD than OCD (i.e., additional impairments in social interaction and communication; APA, 2000; Towbin, 2005). Though further research on this differential diagnosis is needed, a more accurate diagnosis is obtained by taking a detailed behavioral and developmental history (Towbin, 2005).

Comorbidity with ASD

In addition to the core triad of deficits that are used to describe disorders on the spectrum, other behavioral symptoms have come to be recognized as associated features of ASD. These include ID, abnormalities in mood and affect, excessive fears, hyperactivity, odd responses to sensory stimuli, self-injury and aggression (Sverd, 2003). Though some of these areas have been better researched than others, psychiatric and behavioral symptoms that are noted to co-occur with ASD will be reviewed.

Intellectual Disability (ID)

ID occurs in the majority (75 to 80%) of all children with classic autism; however, the rate of ID is much lower among those with other variants of autism (i.e., Asperger's disorder) within ASD. More recent rates of ID in ASD, including individuals with high functioning autism

and Asperger's Disorder, are as low as 20% (Gillberg & Billstedt, 2000). This variation in rates has largely been influenced by changes in criteria over the years. DSM-III-R criteria resulted in high false-positive rates in individuals with ID, while there was less attention and fewer diagnoses given to high-functioning individuals. With the inclusion of Asperger's Disorder in DSM-IV, more individuals without ID were identified with ASD (Volkmar & Klin, 2005). Level of ID has been shown to affect the outcome of early intervention in children with ASD, while children with more severe ID making fewer gains than higher-functioning children (Ben-Izchack & Zachor, 2007).

Psychiatric Conditions

For many years, little attention was given to the existence of co-morbid psychiatric illness in this population due to *diagnostic overshadowing*. Diagnostic overshadowing, originally applied to ID, is based on the tenet that intellectual deficits or autistic symptoms are such salient features that any co-occurring abnormal behavior is attributed to the presence of autism or ID. More recently, there has been increased attention paid to the co-occurrence of symptoms of psychiatric illness. Among those with the most empirical backing are mood disorders, various types of anxiety disorders, and attention deficit hyperactivity disorder (ADHD).

Mood Disorders. Ghaziuddin and colleagues are credited with calling attention to the often co-occurrence of depression in individuals with ASD. However, it was Lainhart and Folstein (1994) in the review of 17 case studies who first suggested that depression may be under-diagnosed in persons with ASD. Other researchers have also reported cases of depression, dysthymia, and bipolar disorders in persons with ASD (Ghaziuddin, Weidmer-Mikhail, & Ghaziuddin, 1998; Wing, 1981) For example, Wozniak, Biederman, Faraone, Frazier, Kim, Millstein and colleagues (1997) reported that out of 66 children referred to a pediatric psychopharmacology clinic who met criteria for an ASD, 38 (58%) had severe major depression.

Prevalence estimates from clinic-based studies indicate that depression frequently co-occurs in persons with ASD (Ghaziuddin, Ghaziuddin, & Greden, 2002), with estimates reported to be 2% in clinic-samples of children and adolescents with autism, and as high as 30% in clinic-samples of adolescents and adults with Asperger's Disorder (Ghaziuddin et al., 1992; Ghaziuddin et al., 1998; Wing, 1981). Lainhart (1999) reported prevalence estimates of co-morbid depression in persons with autism and Asperger's Disorder ranging from 4 to 38%. However, as there have been no large-scale studies of depression in this population, a true prevalence rate is unknown. Ghzaiuddin et al. (2002) report that depression most often occurs in this population during adolescence or young adulthood. Further, it is suggested that depression may also be accompanied by increases in stereotypic movements, self-injury, aggression, ruminations, and obsessions; and most frequently noted by a third-party based on changes in behavior, facial appearance, loss of interest in activities (i.e., decrease in self-care), and in a few cases psychomotor retardation (Ghzaiuddin et al., 2002; Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006).

Similar to what is found in the general population, a co-occurring medical condition may increase an individual's risk for developing depression (Ghaziuddin et al., 2002). To further examine the etiology of this comorbid illness in persons with ASD, Ghaziuddin, Alessi, and Greden (1995) examined the recent life events of persons diagnosed with depression in this population. These researchers found that social and environmental stressors (e.g., bereavement, change of school, parent's marital discord) were important antecedents to depressive episodes in the children diagnosed with depression, whereas those without depression did not report such events. Moreover, DeLong and Nohira (1994) reported higher rates of affective disorder among relatives (i.e., parents and siblings) of persons with ASD. Later, Ghaziuddin and Greden (1998) examined the family histories of children who were diagnosed with depression and ASD and

those who were diagnosed with ASD alone. These investigators found that 77% of children with a diagnosis of depression and ASD had a positive family history of depression, whereas only 30% of those with an ASD and no depression had a family history of depression. One interesting finding is that, overall, the depressed group had a higher full-scale IQ than the non-depressed group. Possible reasons for this finding include the possibility that those with higher IQ are more likely and better able to report symptoms of depression, and also it may be more likely to be identified by mental health experts in persons with higher versus lower intellectual abilities. These findings are consistent with life events and family studies of depression found in the general population literature, and thus lend support to the validity of depression as a comorbid disorder in this population.

Anxiety Disorders. Symptoms of anxiety are common features of ASD, with social anxiety, panic, and obsessive-compulsive disorder noted most frequently (Attwood, 1998). Wozniak et al., (1997) reported that out of 66 children referred to their clinic who met criteria for an ASD, 25 (38%) had multiple anxiety disorders. Green, Gilchrist, Gilchrest, Burton, and Cox (2000) compared a group of adolescents with Asperger's Disorder to a group with conduct disorder who were matched on age and levels of IQ. These authors found that individuals with Asperger's Disorder were more likely to have problems with obsessions (ruminations or rituals) and compulsions, and significantly more problems overall with anxiety related symptoms (i.e., specific fears, worrying, hypochondriasis, non-situational anxiety, or panic) than the conduct disorder group. Other psychiatric symptoms, such as chronic unhappiness, loneliness, inattention, and aggression, were common to both the Asperger's and the conduct disorder groups. Based on this research sample of 20 male adolescents with Asperger's Disorder, 35% (7) met criteria for generalized anxiety disorder and 10% (2) met criteria for specific phobia. Another study by Gillott, Furniss, and Walter (2001) compared the symptoms of anxiety of

children with autism, children with specific language impairment, and typically developing children. These researchers found that the autism group exhibited significantly more symptoms related to OCD, separation anxiety, social anxieties, and other worries than the other groups.

Similarly, Belini (2004) examined the prevalence of anxiety symptoms, as measured by standardized anxiety measures, in 41 adolescents with ASD. The results indicated that adolescents with ASD experienced greater levels of anxiety than adolescents in the general population (research normative sample). Further, 49% of the ASD sample had clinical elevations on measures of social anxiety. Social skills (specifically assertiveness and empathy skills) were negatively correlated to social anxiety. Evans, Canavera, Kleinpeter, Maccubbin, and Taga (2005) examined the fears of children with ASD, and found that children with ASD had higher rates of fear of specific situations, medical, and animal phobias relative to persons with Down Syndrome of similar age and cognitive functioning.

Obsessions and rituals have been noted in early descriptions of autism and have been associated with ASD (Baron-Cohen, 1989; Gillberg & Billsteidt, 2000). Children with ASD oftentimes have restricted, stereotyped interests or obsessions with certain objects or topics (e.g., strings, lining up toys, collecting pencils, turning lights on and off, or talking about a special interest). Individuals with lower cognitive functioning most often engage in stereotypic behaviors, while individuals with higher cognitive abilities typically engage in OCD-like ritualistic behavior or repetitive thoughts. While these interests are not typically described as distressing by the person with ASD, they are often compared to obsessions or compulsions seen in OCD (Bejerot, Nylander, & Lindstrom, 2001; Jackson, 2002). Though the distress associated with OCD is not typically present in persons with ASD with similar symptomatology, it remains unclear of how these repetitive and ritualistic behaviors are related to OCD; further study is warranted (Loveland & Tunali-Kotoski, 2005). A review by Sverd (2003), examining the

prevalence of psychiatric disorders in relatives, reported that OCD is more common in relatives of persons with ASD compared with the relatives of persons without ASD. Further, Bolton, Macdonald, Pickles and colleagues (1994) reported that individuals with OCD were more likely to exhibit impairments in social and communication skills similar to those found in persons with ASD.

Attention Deficit Hyperactivity Disorder (ADHD). Children with ASD often exhibit symptoms similar to those found in ADHD. Roeyer, Keymeulen, and Buysse (1998) reported that 60% of a sample of children diagnosed with PDD-NOS exhibited restless behavior and inability to remain seated. The DSM-IV (APA, 2000) specifies that a diagnosis of autism and ADHD should not be made together, since there is often an overlap in symptoms between these disorders. However, there have been some investigations suggesting that a comorbid diagnosis of ADHD may be valid in some cases of children with ASD (Ghaziuddin, Weidmer-Mikhai, & Ghaziuddin, 1998). For example, Wozniak and colleagues (1997) reported that in their 66 cases of children with ASD, 48 (73%) had ADHD. Children with ASD typically have abnormal levels of activity when compared to peers, which may be hyperactivity or hypoactivity. However, relatively few controlled studies have been conducted to determine if and when this abnormal level of activity is sufficient to warrant a comorbid diagnosis of ADHD. Frazier and colleagues (2001) examined the overlap of symptoms in children with either a diagnosis of ASD alone, ASD plus ADHD, or ADHD alone. They found that symptoms of autism were similar among children with and without comorbid ADHD, and symptoms of the ADHD group were similar to symptoms evinced by the ASD plus ADHD group. Thus, Frazier and colleagues (2001) concluded that ADHD can and does co-occur with ASD. Goldstein and Schwebach (2004) examined the comorbidity of ADHD in 57 children with ASD or ADHD through a retrospective chart review. After comparing the symptom profiles based on questionnaires and

neuropsychological tests, these researchers found that of the 27 children with an ASD there was a clinically distinct group (59% or 16 children) who appeared to meet criteria and warranted a comorbid diagnosis of ADHD. This group's degree and severity of symptoms were similar to children diagnosed with ADHD alone. In another study examining the co-occurrence of these disorders, Yoshida and Uchiyama (2004) selected 53 participants with a diagnosis of ASD, full scale IQ of 70 or higher, and were between the ages of 7 to 15. Of these 53 selected participants, 36 (63%) met criteria for ADHD (19 of 33 with autism, 2 of 3 with Asperger's Disorder, and 15 of 17 with PDD-NOS). Further, these researchers noted that symptoms of ADHD more commonly occur in younger than older children. Interestingly, the literature, as well as anecdotal experience, indicate that it is common for a child with high-functioning autism or Asperger's Disorder to be identified by professionals as having ADHD rather than an ASD (Yoshida & Uchiyama, 2004).

Motor Disorders and Tourette's Syndrome

A motor disorder, called deficits in attention, motor control, and perception (DAMP, also referred to as developmental coordination disorder; DCD) is associated with ASD. In Scandinavia, DAMP is considered to be a combination of ADHD and motor-perceptual impairments. Studies by Gillberg (1983), Kadesjo and Gillberger (1999), and Landgren, Pettersson, Kjellman and Gillberg (1996) examined the prevalence of DAMP in Swedish 6- and 7-year olds. These researchers found that more than half of the children who had severe DAMP also had the triad of impairments associated with autism, though these features were less severe than those found in classic autism. Of these children with severe DAMP and autistic features, approximately half met full criteria for Asperger's Disorder.

Similarly, clumsiness and abnormal gait have been associated with Asperger's Disorder (Gillberg & Billstedt, 2000). Tics and Tourette's Syndromes have been associated with ASD.

According to Gillberg and Billsteidt's (2000) review, several population studies conducted in Sweden indicate that 10 to 20% of all school-aged children with Asperger's Disorder met criteria for Tourette's Syndrome. Moreover, one such population study indicated that 80% of children with a diagnosis of Asperger's Disorder met criteria for a tic disorder other than Tourette's.

Sleep Disorders

It is common for children with autism to have an abnormal pattern of sleeping (Richdale & Prior, 1995). Richdale (1999) estimate the prevalence of sleep problems in children with ASD to range from 44 to 83%, exceeding estimates of sleep disorders in typically developing children. A survey study conducted by Williams, Sears, and Allard (2004) of parents of 210 children with autism indicated that common problems are difficulty falling asleep (53.3%), restless sleep (40%), unwillingness to fall asleep in bed (39.5%), frequent waking (33.8%), and difficulty arousing (31.5%). Further, Hoffman, Sweeney, Gilliam, Apodaca, Lopez-Wagner, and Castillo (2005) in another study found that a child's sleep disturbances (i.e., sleep disorder breathing and parasomnias) were significant predictors of symptoms related to autism, including stereotypies and difficulties in social interaction.

Speech and Language Disorders

Speech and language disorders are common in those with Asperger's Disorder, whereas lower functioning children with ASD are often nonverbal or have minimal verbal ability (Gillberg & Billstedt, 2000). Most often, young children with autism are referred for evaluation due to delays in expressive language. For many who do acquire expressive language, abnormal speech and particular oddities in pitch and prosody are common. Oftentimes, abnormal or precocious articulation is noted in individuals with language. Frequently persons with high-functioning autism or Asperger's Disorder are described as having pedantic speech. Furthermore, the pragmatics of speech is another area of difficulty for these individuals. These usage problems

vary widely, and include delayed echolalia, neologisms, self-talk, and difficulties understanding non-literal phrases (Tager-Flusberg, Paul, & Lord, 2005). Children with Asperger's Disorder often have difficulties in engaging in conversations with others; they do not engage in turn-taking when talking with others (Ghaziuddin & Gerstein, 1996). Other abnormalities in language and speech have been associated with this population, Kopp and Gillberg (1997) found that children with selective mutism often (i.e., one out of every five) also meet full criteria for Asperger's Disorder.

Sensory Impairments/Abnormal Sensory Reactions

Hearing and visual impairments in children are more common among those with autism than those in the general population. According to a review of comorbid conditions by Gillberg and Billstedt (2000), 10 to 20% of children with classic autism have moderate to severe or profound hearing impairments. Further, blindness and retinopathy of prematurity (ROP) frequently occur in this population. In fact, autism occurs in one in every two cases of ROP (Ek, Fernell, Jacobsson, & Gillberg, 1998).

Abnormal sensory reactions are commonly associated with ASD (Gillberg & Billstedt, 2000; Attwood, 1998). Approximately 40% of children with autism and Asperger's Disorder have some sensory sensitivity (Rimland, 1990). Attwood (1998) reported that the most common sensitivities involve sound, touch, light intensity, colors, aromas, and tastes. In a community study of 75 children with ASD, Bromely, Hare, Davison, and Emerson (2004) found that 71% were hypersensitive to sound, 52% to touch, 41% to smell, 40% to taste. Further, 23% were hypersensitive to pain, whereas 45% were hyposensitive to pain.

Attwood (1998) described three types of sound sensitivities noted in these individuals: 1) sudden, unexpected noises (i.e., dog barking, telephone ringing); 2) high-pitched, continuous noise (i.e., small electric motors used in kitchen); and 3) confusing, complex, and multiple

sounds in noisy gatherings of people (i.e., shopping mall). Children with ASD oftentimes experience these sounds more intensely than others, and may notice these auditory stimuli when others do not. Tactile sensitivity, or "tactile defensiveness," is often described as avoidance of physical contact or strong preferences for some textures of clothing over others. Though noted more rarely, some children experience visual sensitivity. This is often described as sensitivity to particular levels of light, brightness, or color. Moreover, some persons with ASD report that smells are overpowering. Food selectivity is commonly associated with ASD. This selectivity can be in terms of taste, color, or texture of food. Idiosyncratic meal time behavior, including food smearing or only drinking or eating from certain materials (i.e. sippy cups), is often reported. These behaviors can result in eating problems including significant weight-loss (Schreck & Williams, 2005). In contrast to these sensitivities, children with ASD oftentimes have minimal reactions to pain and temperature. It is not uncommon for parents of children with ASD to report that their children do not react when exposed to extreme temperatures or pain as a result of an accident, fall, or insect bite. This insensitivity can be of particular concern as parents are often unaware that a child is in need of medical attention for a chronic ear infection or fractured bone because the child does not report significant discomfort (Attwood, 1998).

Epilepsy and Other Medical Conditions

A review conducted by Bryson and Smith (1998) suggested that at least 25 to 30% of individuals with autism have an associated medical condition. Among the most prevalent conditions in this population (aside from sensory impairments that were previously discussed) are tuberous sclerosis, neurofibromatosis, and epilepsy. According to Gillberg and Coleman (1996), 25% of all children with autism, and 12.5% of children referred to an autism clinic, have a well-defined, specific medical diagnosis. Further, various genetic syndromes have been

associated with ASD, including tuberous sclerosis, Fragile X Syndrome, partial tetrasomy, Angelman Syndrome, and Moebios Syndrome (Gillberg & Billstedt, 2000).

Epilepsy has been suggested to occur in up to 30% of individuals with autism (Bryson & Smith, 1998). However, these rates are much lower among those with high functioning autism or Asperger's Disorder (Gillberg & Billstedt, 2000). Seizures tend to occur in infancy, but tend to have a peak onset during adolescence. Steffenburg, Steffenburg, and Gillberg (2003) conducted a survey of 90 children aged 6 to 13 years with epilepsy and ID. It was found that 34 children (38%) had an ASD. Further, partial seizures were more common and general seizures less common among those with ASD compared to children without ASD in their sample. Steffenburg, Steffenburg, and Gillberg (2003) cautioned that autistic-like behavior may be misinterpreted as epileptic seizures. Moreover, high doses of antipsychotic medications may provoke seizures and may result in cognitive side-effects in this population.

Challenging Behaviors

Challenging behaviors such as stereotypies, aggression, and self-injury have been noted in persons with neurological disorders, intellectual disabilities, and ASD (Gillberg & Billstedt, 2000; Matson & Nebel-Schwalm, in press; Militerni, Bravaccio, Falco, Fico, & Palermo, 2002; Symons, Sperry, Dropik, & Bodfish, 2005). The presence of these behaviors is an important factor in the quality of life of individuals with ASD. The presence of a challenging behavior is a significant stressor for the caregivers (Hastings & Brown, 2002), predicts the need for residential care outside of the family, increases risks for the use of physical and chemical restraint (Matson & Minshawi, 2006), and increases risks of being excluded from general community services (i.e., day program and more restrictive education services; Bushbacher & Fox, 2003). Risk factors identified for exhibiting challenging behaviors, such as self-injury and aggression, and the maintenance of these behaviors over time, are severe impairments in ID, deficits in

communication/language skills, and impairments in social skills (McClintock, Hall, & Oliver, 2003; Murphy et al., 2005). As impairments in communication and social relatedness are core features of autism, and the presence of severe ID in this population is common, children with ASD are particularly vulnerable to the presence of challenging behaviors. These behaviors greatly impact the life of the person with ASD and often are a major concern of parents when the child with ASD is referred to intervention services.

RATIONALE

The purpose of the present study is to examine the reliability and construct validity of parent ratings on the Autism Spectrum Disorder-Diagnostic for Children (ASD-DC), an assessment scale designed to aid in the identification and differential diagnosis of ASD. Given the importance of early identification and the limited number of instruments that accurately assess the full spectrum of ASD, initial investigation of the psychometric properties of this newly developed scale is warranted. To accomplish this aim, this study was divided into two studies. Study 1 aimed to evaluate the reliability of the ASD-DC and Study 2 aimed to examine the construct validity of the scale in measuring the core symptoms associated with ASD (impairment in communication, social interaction, and restricted/stereotyped interests or behavior).

STUDY 1

Study 1 examined the reliability of the ASD-DC. Specifically, this study evaluated the test-retest, inter-rater, inter-item and scale correlations, and the internal consistency of the total scale.

Method

Participants

Parents and caregivers of children with and without developmental delays were recruited to participate in this study. Participants were recruited from centers specializing in developmental disabilities, parent support and advocacy/community groups, outpatient clinics, and professional and participant-referrals in California, Connecticut, Michigan, New York, Georgia, and Louisiana; and, public and private elementary schools in Louisiana. The majority (86%) of data collected for this study was collected from Louisiana.

As children were recruited from several different sites and methods of diagnosis may vary between sites, research criteria were set to clearly define the designation of ASD for this research and to ensure a sufficient number of children with an ASD were included in the study. A child must have had a minimum of three DSM-IV-TR/ICD-10 criteria endorsed on the DSM-IV-TR/ICD-10 checklist (described in more detail below) to qualify for a diagnosis of ASD for the purpose of this study. These endorsements must include two deficits in social interaction and one in another area of functioning (i.e., communication or repetitive interest). These criteria were chosen since this is the minimum criteria listed in DSM-IV-TR (APA, 2000) necessary for a diagnosis of PDD-NOS, the ASD diagnosis with the fewest criteria. Sixty-seven children (50.8%) met criteria as an ASD participant for this study, while 65 (49.2%) children did not meet the research criteria for an ASD nor did they have other psychopathology noted by the informant. Mean total item endorsement on the DSM-IV-TR/ICD-10 checklist for the ASD group was 10.3

(range = 3 to 18), whereas the mean for the control group was 0.24 (range = 0 to 3). Children who did not meet research criteria for an ASD and had a previous diagnosis of other psychopathology were excluded from this study. The DSM-IV-TR/ICD-10 Checklist is presented in Appendix A. The test-retest, inter-rater reliability, and internal consistency of the DSM-IV-TR/ICD-10 checklist are reported in Table 1.

Table 1
Reliability coefficients for the DSM-IV-TR/ICD-10 Checklist

[a]Item	Inter-Rater (*n*=42)	Test-Retest (*n*=32)	[b]Internal Consistency (*N*=125)
[c]**Social Interaction**	*.73*	*.94*	*.86*
a. Impairment in the use of multiple nonverbal behavior, such as eye-to-eye gaze (e.g., eye contact), body posture, or gestures	.70	.93	
b. Failure to develop peer relationships appropriate to developmental level (e.g., little to no interest in forming friendships or lack understanding of how to interact socially with others)	.71	.93	
c. Lack of spontaneous seeking to share enjoyment, interest or achievements with others (e.g., not showing, bringing, or pointing out objects of he/she finds interesting)	.54	.77	
d. Lack of social or emotional reciprocity (e.g., not actively participating in social play or games, preferring solitary activities)	.65	.93	
e. Rarely seeking or using others for comfort in times of stress or offering comfort or affection to others in stress	.44	.48	
[c]**Communication**	*.89*	*.90*	*.87*
a. Delay in development or lack of spoken language (i.e., not accompanied by an attempt to communicate through alternative ways to communicate such as gestures or mime)	.90	.86	
b. In those with adequate speech, impairment to initiate or sustain conversations with others	.67	.57	
c. Stereotyped and repetitive use of language or idiosyncratic language (e.g., using words in a peculiar or odd way)	.63	.73	
d. Lack of varied, spontaneous make-believe play (e.g., pretend play) or social imitative play (e.g., imitating adults) appropriate to developmental level	.75	.69	

(table cont.)

e. Lack of emotional response to others' verbal or non-verbal communication	.57	.69	
f. Lack of variation in the rhythm or emphasis of speech (e.g., speech is monotone; without change)	.75	.52	
g. Impaired use of gestures to aid spoken communication	.55	.58	
[c]**Restricted, repetitive, and stereotyped patterns of interest or behavior**	*.78*	*.94*	*.86*
a. Preoccupation with one or more stereotyped and restricted patterns of interest of abnormal intensity or focus (e.g., few interests)	.64	.93	
b. Inflexible adherence to specific, nonfunctional routines or rituals	.60	1.00	
c. Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or other complex whole-body movements such as rocking, dipping or swaying)	.58	.83	
d. Persistent preoccupation with parts of objects (e.g., buttons, parts of the body)	.69	.52	
e. Specific attachments to unusual objects (e.g., string)	.27	.70	
f. Distress over changes in small, non-functional details of the environment	.65	.89	
Delays or abnormal functioning in at least one of the previous areas (#1-3) was present prior to age of 3.	*.76*	*.79*	
[c]*Total Checklist*	*.89*	*.97*	*.95*

[a] Item inter-rater and test-retest reliabilities were calculated with kappa coefficients.
[b] Scale and subscale internal consistency was calculated using Cronbach's alpha.
[c] Scale and subscale inter-rater and test-retest reliabilities were calculated with Pearson's r.

One participant was excluded from data analysis due to missing data (i.e., more than 5% of the ASD-DC) and 6 participants were excluded due to missing questionnaires (i.e., DSM-IV-TR/ICD-10 checklist), thus a total of 125 ratings of children remained for data analysis. The following data reflect those participants who were retained in the database. There were a total of 107 parent/caregivers who served as primary informants for 125 children (i.e. 18 informants rated two children in the sample). Thirty-two parent/caregivers served as secondary informants for 42 children (i.e., 10 secondary informants rated two children in the sample).

The children's ages ranged from 2 to 16 years, with an average of 7 years. Results of an independent t-test revealed that the groups did not differ significantly in terms of age. Ninety-

seven children (78%) were White, 14 (11%) were Black, 8 (6%) were Hispanic, 1 was of another ethnic background (1%), and 5 were unidentified (4%). Chi-square analysis indicated that the groups did not differ significantly by ethnicity. Seventy-seven (62%) children were male, while 48 (38%) were female. There were significantly more females in the control group than the ASD group, X^2 (df = 3, N= 125) = 10.50, p< .005.

Sixty-one (49%) of the children's informants indicated that the child (all in the ASD group) had one or more previous diagnoses given by a mental health/medical professional at the time of the study. These diagnoses were noted as follows: Autistic Disorder, Asperger's Disorder, PDD-NOS, Anxiety Disorder, Apraxia, Attention Deficit Hyperactivity Disorder, Bipolar Disorder, Depression, Developmental Delay (unspecified), Down Syndrome, Hyperactivity, Hypersomnia, Iodine Deficiency Disorder, Non-verbal Learning Disability, Obsessive-Compulsive Disorder, Stereotypic Movement Disorder, Tics, Selective Mutism, and Psychopathology (unspecified). Six of the children were identified by informants as having an intellectual disability (all six met criteria for the ASD group). Twenty-five (20%) of the children (23 were in the ASD group) were prescribed one or more psychotropic medications at the time when questionnaires were completed. Prescribed medications included Antidepressants, Antipsychotic, Anxiolytics, Mood Stabilizer/Anti-Epileptic Medications, and Psychostimulants. Two children (3%) were identified as having seizures or epilepsy, and one child (2%) was identified as being confined to a bed or wheelchair. These three children met criteria for the ASD group. No other physical or medical difficulties were noted by informants. Table 2 displays the children's demographic information by group.

Table 2
Demographic Characteristics of Children of Parent Participants (N=125)

	Group	
	ASD Group (n= 62)	Control Group (n=63)

(table cont.)

	N	%	*n*	%
Mean Age	8.02		7.46	
2 to 5 years (preschool)	15	24	15	24
6 to 11 years (child)	36	58	44	70
12 to 16 years (adolescent)	11	18	4	6
Gender				
Male	47	76	30	48
Female	15	24	33	52
Ethnicity				
White	46	74	51	81
Black	8	13	6	9
Hispanic	5	8	3	5
Other	1	2	0	0
Unspecified	2	3	3	5
[a]Previous Diagnoses				
Autistic Disorder	31	50	-	-
Asperger's Disorder	5	8	-	-
PDD-NOS	13	21	-	-
Anxiety Disorder	4	6	-	-
Apraxia	2	3	-	-
Attention Deficit Hyperactivity Disorder	7	11	-	-
Bipolar Disorder	1	2	-	-
Depression	1	2	-	-
Developmental Delay (Unspecified)	1	2	-	-
Down Syndrome	1	2	-	-
Hyperactivity	1	2	-	-
Hypersomnia	1	2	-	-
Iodine Deficiency Disorder	2	3		
Non-Verbal Learning Disability	1	2	-	-
Obsessive-Compulsive Disorder	1	2	-	-
Tics	1	2	-	-
Selective Mutism	1	2	-	-
Psychopathology (unspecified)	1	2	-	-
[b]Prescribed Medications	23	37	2	3
Antidepressants	7	11	1	2
Antipsychotics	5	8	0	0
Anxiolytics	1	2	0	0
Mood Stabilizers/Anti-Epileptic	6	10	0	0
Psychostimulants	11	18	1	2
Verbal Ability				
Yes	53	85	63	100
No	9	15	0	0

[a] These were diagnoses informants listed on background questionnaire that were given by professionals prior to this study. Some of these diagnoses do not conform to those recognized in the DSM-IV-TR. Ten children had multiple diagnoses (range = 2 to 4).

[b] Thirteen children were prescribed multiple medications (range = 2 to 4).

Primary informants included mothers, fathers, foster parents, and grandparents of the children. Secondary informants included mothers, fathers, foster parents, grandparents, and other caregivers (e.g., in-home nanny, other relatives who reside in the household or see the child daily). The Hollingshead's Four Factor Index of Social Status is a commonly used measure of socioeconomic status (SES) that is based on the parents' education level and occupation. Hollingshead (1975) defined SES levels calculated from education and occupation as follows: scores from 8 to 19 are considered "Low," 20 to 20 are "Low-Middle," 30 to 39 are "Middle," 40 to 54 are "Upper-Middle," and 55 to 60 are "Upper." Demographic information related to SES was collected for 61 out of the 125 ratings (49%) of the study sample. Only a sub-sample was obtained as this demographic questionnaire was added after the beginning of the data collection. Based on this sub-sample of participants, the majority (67%) of the informants were of the Upper-Middle class. The demographic questionnaire inquiring about education and occupation is included in Appendix B. A Chi-Square analysis revealed no significant differences between the ASD and control groups in terms of SES level. Demographic and SES characteristics (as measured by the Hollingshead index) of 49% of the sample are presented in Table 3.

Table 3
Demographic Characteristics of Primary Informants of 49% of the Sample

		Group			
		ASD Group (*n*=38)		Control Group (*n*=23)	
Mean Age (Range)		39.0 (24 to 56)		38.0 (23 to 40)	
		n	%	*n*	%
Marital Status					
	Never Married	2	5	1	4
	Married	28	74	20	87
	Separated	7	18	0	0
	Divorced	0	0	2	9
	Unspecified	1	3	0	0
Ethnicity					
	White	31	82	18	78
	Black	5	13	2	9
	Hispanic	2	5	3	13

(table cont.)

Education				
Junior High/Middle School	0	0	1	4
High School Graduate	5	13	4	17
Partial College or specialized training	14	37	2	9
University Graduate	12	32	11	48
Graduate degree	5	13	5	22
Unspecified	2	5	0	0
[a]SES Level				
Upper	8	21	5	22
Upper-Middle	26	68	15	65
Middle	1	3	2	9
Lower-Middle	3	8	1	4
Lower	0	0	0	0
Biological Parent	36	95	21	91

[a] Based on the Hollingshed Four Factor Index of Social Status (Hollingshead, 1975).

Measures

DSM-IV-TR/ICD-10 Checklist. As the DSM-IV-TR (APA, 2000) or ICD-10 (WHO, 1992) are considered the broadly accepted, international guidelines of diagnostic utility (Volkmar & Klin, 2005), they are included as the method to which children will be assigned to the case group and systematically determining ASD diagnosis for this research. Parents were asked to write "yes" if the item applied to their child, and "no" if the item did not apply. As defined in DSM-IV-TR (APA, 2000), the checklist included symptoms from the three core areas: impairments in social interaction, impairments in communication, and restricted, repetitive, and stereotyped patterns of behavior. Social impairments include the following items: "marked impairment in nonverbal behaviors such as eye-to-eye gaze"; "failure to develop peer relationships"; "lack of spontaneous seeking to share enjoyment, interests with others"; and "lack of social/emotional reciprocity." Communication impairments include the following items: "delay in the development of spoken language"; "impairment in the ability to initiate or sustain conversation with others"; "repetitive or idiosyncratic language"; and "lack of varied spontaneous make believe play or social imitative play appropriate to developmental level." Restricted and stereotyped patterns of behavior include the following items: "preoccupation with

one or more stereotyped or restricted patterns of interests"; "inflexible adherence to nonfunctional routines"; "stereotyped and repetitive motor mannerisms"; and "persistent preoccupation with parts of objects." As some differences remain between the DSM-IV-TR and the ICD-10, criteria listed on the ICD-10 (WHO, 1992) that are not included on the DSM-IV-TR were also listed, such as "rarely seeking or using others for comfort in times of stress or comforting others when they are stressed"; "lack of emotional response to other verbal or non-verbal communication"; "lack of variation in speech"; "impaired use of gestures to aid spoken communication"; "specific attachments to unusual objects"; and "distress over changes in small, non-functional details in the environment." Most symptoms were accompanied with examples to aid in the participant's understanding. Finally, the checklist concluded with an item inquiring if delays or abnormalities in one of the three core areas were noted prior to age 3.

Autism Spectrum Disorder-Diagnostic for Children (ASD-DC). The ASD-DC is a newly-developed informant-based assessment scale designed to assess symptoms of Autistic Disorder, Asperger's Disorder, and PDD-NOS in children. The scale consists of 71 items. Parents or caregivers (i.e., parents, direct care attendants, or teachers) are asked to rate items 1 to 65 for the "extent that it is/was ever a problem." They are to compare the child to other children his/her age and rate the child's behavior as 0 (not different; no impairment), 1 (somewhat different; mild impairment), or 2 (very different; severe impairment). Items 66 to 71 are intended to assess splinter skills (i.e., precocious ability to read, exceptional memory, or artistic ability) that are often associated with children with ASD. These items are rated only if the child in question has exceptional skills beyond what is expected for the child's level of functioning. Similar to the previous ratings, these items are rated as 0 (not different), 1 (somewhat different), or 2 (very different) by comparing the child to other children his/her age.

Scale items were generated through a series of steps suggested by Crocker and Algina (1986) and DeVellis (1991). This included a comprehensive research review of the ASD literature and current diagnostic guidelines (i.e., DSM-IV-IV; ICD-10), as well as critical incidents and observations noted by a clinical psychologist with more than 30 years of experience with this population. These items were then reviewed by a child clinical psychologist who had extensive experience with this population for expert review. This expert review generated additional items, as well as suggestions for minor revisions to the original set of items. Items were then edited and adjusted to ensure that they were understandable to persons not familiar with terminology frequently used in this field. Subsequently, the assessment instrument was piloted by administering the items to several caregivers of adults with developmental disabilities who reside in a developmental center, and parents of children with and without developmental disabilities who reside in the community.

Procedures

Parent informants were recruited through information distributed via hand-outs at schools or parent advocacy/support groups, when seeking services at an outpatient clinic involved in this study, or from referrals made by word of mouth from other participants in the study or professionals in the community. Parents who indicated an interest in participating were given additional information about the study in order to obtain informed consent to participate. Informants received the ASD scale either via mail or during a visit to one of the sites participating in this research. All questionnaires were completed by the parents or caregiver of the child, by rating each item according to the directions printed at the top of the questionnaire. To ensure that all informants had the opportunity to ask questions to administrators, follow-up phone calls and/or emails were sent to all those who received the questionnaires via mail. Research assistants who had been trained in the scale administration and research procedures

made the follow-up phone calls/emails. Further, research assistants attended periodic research meetings to answer questions and resolve any problems that arose during data collection. All questionnaires sent out via mail were returned via self-addressed, stamped envelopes. These procedures were approved by the Institutional Review Boards at various sites of participant recruitment.

Data Analysis

Reliability involves the degree to which a result will be the same when something is measured multiple times (Witt, Elliot, Daly, Gresham, & Kramer, 1998). An integral part of test construction involves the examination of reliability. As assessments, by nature, are subject to error variance, reliability was examined to ensure that the error variance associated with the ASD-DC was minimized. There are several aspects of reliability that were examined in this study. These included: test-retest, inter-rater, item-analysis, and internal consistency of the scale. Each aspect of reliability entails several steps which are described below.

An *a priori* power analysis was conducted to determine the sample size required. As reliability coefficients of .80 or above are considered appropriate for clinical assessment measures (Witt, Elliott, Daly, Gresham, & Kramer, 1998), it is expected that there will be a large effect size for the reliability correlations. The power analysis computer program GPOWER (Faul & Erdfelder, 1992) was used in order to determine the sample size necessary to detect a large effect size of $r = 0.5$ for a two-tailed correlation (Cohen, 1992). In the behavioral sciences with an *a priori* level of significance (α) of .05, power should be set at .80 (Chase & Tucker, 1976). Results of the GPOWER power analysis indicated that a total sample size of 26 was necessary to achieve power of .80 when α is set at .05.

Inter-rater Reliability

Inter-rater reliability determines the extent to which the same result was obtained when measuring the same information from two different people at the same point in time (DeVellis, 1991). This consisted of two informants from similar settings (i.e., home) who made their ratings for the same child (i.e., two parents, one parent and one grandparent). The level of agreement for item endorsements between informants was evaluated using weighted kappa. Weighted kappa was calculated using an online computer program (Lowry, 2001). Unlike kappa which accounts for only agreement or disagreement between raters and typically is recommended for dichotomous ratings, weighted kappa also accounts for the degree of disagreement between ratings for ordinal data (Cohen, 1968). For example, a disagreement in terms of the presence or absence of a symptom would have more weight than a disagreement in terms of severity, such as a symptom being identified as present and mild vs. the symptom being identified as present and severe. Weighted kappa has been suggested for use with ordinal type assessment instruments so that different kinds of disagreements between raters can be weighted differently (Cichetti, & Sparrow, 1981; Cicchetti, 1994). Further, it has been suggested that weighted kappa is more appropriate than Cohen's kappa for dichotomous-ordinal type data in clinical rating scales (Cicchetti & Sparrow, 1981; Cicchetti, Volkmar, Sparrow, Cohen, Fermanian, & Rourke, 1992; Jakobsson & Westergren, 2005). Linear weighting is the most common method used, recommended for data that has both nominal and ordinal features, and was used in this analysis (Cicchetti, et al., 1992).

Landis and Koch (1977) suggested that kappa-type coefficients of .40 or .59 are considered moderate inter-rater reliability, .60 to .79 are considered substantial, and .80 or above are considered outstanding. However, Cicchetti and Sparrow (1981) provide more instructive guidelines for interpreting item reliabilities and scale development. Similarly, these authors

suggest that item coefficients below .40 have poor clinical significance, coefficients in the range of .40 to .59 have fair clinical significance, coefficients in the range of .60 to .74 have good clinical significance, and coefficients in the range of .75 to 1.00 are considered to be excellent. Cicchetti and Sparrow's (1981) guidelines propose that a stringent but simple criterion is to retain items that have good to excellent reliability (i.e., coefficients >/= .60). Therefore, all items with inter-rater reliabilities with coefficients less than .60 were removed from the scale.

Test-retest Reliability

Test-retest reliability determines the extent to which the same result will be gained when measuring the same information from the same person at two separate points in time (DeVellis, 1991). Similar to inter-rater reliability, the level of agreement for item endorsements between test periods was evaluated using weighted kappa. As previously discussed, test-retest item reliability coefficients less than .60 were removed from the scale.

Item-analysis and Internal Consistency

An important step in scale construction and evaluation is examining the extent to which items are appropriate for the assessment measure in question. First, a correlation matrix was computed to examine the extent to which items were inter-correlated. As the correlation among the items increases, the reliability of the individual items and the scale as a whole also increase (DeVellis, 1991). Next, to evaluate how well each item is associated with the total scale, the item-scale correlations were examined (i.e., the correlation of the item being evaluated with all scale items, excluding itself; DeVellis, 1991). Then, the variance and means of the items were evaluated to ensure that the items discriminate among individuals. Subsequently, coefficient alpha was computed for the scale with the retained items to give an estimate of the internal consistency of the scale (DeVellis, 1991). Good estimates of internal consistency are those with alpha >/= .80 (Clark & Watson, 1995; Cicchetti, 1994).

Results

Inter-rater Reliability

Inter-rater reliability data was collected for 42 informants or 34% of the total sample (i.e., 21 in each group). Informants self-selected to participate in the inter-rater portion of the study by having a second informant complete the questionnaires. Based on the results of the power analysis conducted prior to data analysis, this sample of 42 was sufficient to examine the inter-rater reliability of the ASD-DC. Children in the ASD group were matched as best as possible on variables of age and gender with children in the control group to minimize differences between groups. Despite attempts to match on these variables, results of a chi-square test reveal differences in gender across groups, X^2 (df =1, N=42) = 11.96, p<.005. There were significantly more females in the control group than the ASD group. There was no difference in age between groups for this analysis. To ensure that there were no confounding effects of education level and/or SES that may skew the data for this particular analysis (i.e., including a large number of informants who may have difficulty understanding questionnaires due to limited reading skill or low education levels), frequency counts of the SES and education levels of informants were examined. There were 22 informants who participated in the inter-rater portion of the study in which SES information was collected. All of these informants had a minimum of a high school diploma, with the majority of these having a degree from a university (59%). Similar to the total sample demographics, the mean SES of this group was Upper-Middle. There was one informant with SES in the Middle range while others were in the Upper-Middle and Upper SES ranges. A median split for SES level of informants was made to create high and low SES groups. The total ASD-DC scale inter-rater correlation was compared across groups to examine if there were differences in the reliability of the scale based on SES level. A t-test revealed no significant difference in the total scale correlations between SES groups. The total scale inter-rater

correlation with all items included was r = .83. Weighted kappa was calculated for each of the 71 items of the ASD-DC scale. Mean item inter-rater reliabilities among the 71 items was $\kappa_{\omega} = .58$ (range = .13 to .85). There were 33 items that had $\kappa_{\omega} < .60$.

Test-retest reliability

Test-retest reliability data was collected for 34 informants or 27% of the total sample (17 in each group). Informants self-selected themselves into this part of the study by completing the measures a second time. The interval between the test-retest averaged 7 weeks (range = 1.5 to 21 weeks). As the test-retest interval had a wide range, the distribution of weeks between the test-retest interval was examined and standardized z-scores were calculated. Cases with z-scores greater than 3.29 were identified as potential outliers. Nine cases were identified. In order to ensure that the presence of these potential outliers would not skew the test-retest reliability of this measure, reliability data was computed for the cases that were identified as potential outliers separately from the rest of the sample. A t-test revealed no significant differences in the reliability of the scale between the potential outliers and the rest of the sample. Given this finding, all 34 informants were retained in the test-retest analysis.

As described above, 34 participants is sufficient to achieve power of .80 when α is set at .05. Again, children in the ASD group were matched as best as possible with children in the control group to minimize differences. Chi-square and t-test analysis revealed no significant gender or age differences between groups for this sub-sample. Again, frequency counts of the 21 test-retest informants for which SES data was collected was examined to ensure there were no outliers that may skew the reliability data. Similar to the inter-rater informants, all informants had at minimum an education level of a high school graduate and the majority of informants (57%) had a degree from a university. SES levels ranged from the Middle to the Upper levels; the majority of informants' household SES (71%) was in the Upper-Middle range. A median

split for SES was calculated. The total ASD-DC scale test-retest correlation was compared across high and low SES groups to examine if there were differences in the reliability of the scale based on SES level. A t-test revealed no significant difference in the total scale correlations between SES groups. Total scale test-rest reliability with all items was $r = .96$. Weighted kappa was calculated for each of the 71 items of the ASD-DC scale. Mean item test-retest reliabilities among the 71 items was .74 (range = .44 to .94). There were 7 items (i.e., only 1 additional item from the 33 identified in the inter-rater analysis) that had a test-retest coefficients of $\kappa_\omega < .60$. The 34 items with $\kappa_\omega < .60$ for either inter-rater and/or test-retest reliability were removed from the scale. Thus, there were 37 items retained in the scale. Table 4 displays the weighted kappa coefficients and percent agreement for the inter-rater and test-retest reliability of the original 71 items of the ASD-DC.

Internal Consistency

Inter-item correlations for the 37 remaining items averaged .71 with a range of .30 to .93. The average item-scale correlation ranged from .57 to .92, with an average of .84. Table 5 displays the inter-item and item-total correlations of the 37 retained items. The average item mean was .66 (range = .31 to .84) and the average item variance was .68 (range = .35 to .83). Further, the internal consistency of the scale was $\alpha = .99$. The exclusion of any item did not result in a substantial increase in alpha. Subsequently, item and scale inter-rater and test-retest reliabilities were recalculated with the 37 items retained in the scale. The final scale mean inter-rater item reliability was .68 (range = .60 to .85), and the mean test-retest item reliability was .79 (range = .60 to .94). Further, total scale inter-rater reliability was r = .85 and the total scale test-retest reliability was $r = .98$.

Table 4

Inter-rater and Test-retest Item Reliability

		Inter-rater Reliability (*n*=42)		Test-Retest Reliability (*n*=34)	
	Item Inter-rater and Retest Reliability	%	κ_ω	%	κ_ω
1	Communication skills.*	.83	.78	.88	.88
2	Intellectual abilities (i.e., as smart as others his/her age).	.69	.54	.79	.74
3	Age appropriate self-help and adaptive skills (i.e., able to take care of self).*	.74	.63	.76	.69
4	Engages in repetitive motor movements for no reason (e.g., hand waving, body rocking, head banging, hand flapping).*	.81	.68	.88	.83
5	Verbal communication.*	.79	.71	.82	.82
6	Prefers clothing of a certain texture.	.68	.47	.88	.78
7	Prefers foods of a certain texture or smell.*	.76	.66	.82	.69
8	Ability to recognize the emotions of others.*	.80	.69	.82	.76
9	Maintains eye contact.*	.71	.60	.82	.77
10	Use of language to communicate.*	.76	.71	.91	.91
11	Social interactions with others his/her age.*	.69	.60	.88	.87
12	Reactions to normal, everyday sounds (e.g., vacuum, coffee grinder).	.71	.47	.82	.69
13	Response to others' social cues.*	.79	.70	.79	.77
14	Reaction to normal, everyday lights (e.g., streetlights, etc.).	.76	.13	.88	.73
15	Peer relationships.	.67	.55	.88	.88
16	Rhythm of speaking (e.g., sing-song; *If nonverbal, rate "0"*).	.74	.49	.76	.45
17	Use of language in conversations with others.*	.71	.66	.85	.84
18	Shares enjoyment, interests, or achievement with others (e.g., parents, friends, caregivers).	.69	.54	.82	.77
19	Ability to make and keep friends.*	.73	.64	.94	.94
20	Interest in participating in social games, sports, and activities.*	.64	.60	.82	.75
21	Interest in another person's side of the conversation (e.g., talks to people with intention of hearing what others have to say).*	.88	.85	.85	.82
22	Able to understand the subtle cues or gestures of others (e.g., sarcasm, crossing arms to show anger).*	.83	.79	.85	.84
23	Use of too few or too many social gestures.*	.71	.62	.82	.80

(table cont.)

24	Body posture and/or gestures.*	.81	.73	.85	.77
25	Communicates effectively (e.g., using words, gestures or sign language).*	.81	.73	.82	.75
26	Likes affection (e.g., praise, hugs).	.76	.48	.94	.86
27	Displays a range of socially appropriate facial expressions.*	.76	.60	.85	.75
28	Restricted interests and activities.*	.83	.76	.82	.82
29	Motivated to please others (e.g., peers, caregivers, parents).	.74	.59	.73	.67
30	Eye-to-eye gaze.*	.76	.65	.82	.78
31	Reaction to sounds and sights.	.76	.57	.85	.76
32	Walks or runs on toes/balls of feet (*If unable to walk/run, rate "0"*).*	.80	.63	.94	.86
33	Awareness of the unwritten or unspoken rules of social play (e.g., turn taking, sharing).	.66	.55	.76	.73
34	Facial expression corresponds to environmental events.	.64	.51	.79	.67
35	Sticking to odd routines or rituals that don't have a purpose or make a difference.	.64	.52	.73	.59
36	Abnormal preoccupation with the parts of an object or objects.	.64	.46	.70	.62
37	Plays appropriately with others.*	.73	.62	.85	.83
38	Reads nonverbal cues (body language) of other people. (*If blind, rate "0"*)*	.80	.78	.76	.72
39	Speaks in monotone (e.g., voice is flat, does not change in sound; *If nonverbal, rate "0"*).	.70	.32	.94	.80
40	Expects others to know their thoughts, experiences, and opinions without communicating them (e.g., expects others to "read his/her mind").*	.78	.64	.82	.73
41	Interest in a highly restricted set of activities.	.73	.61	.69	.47
42	Talking to others in a social context (*If nonverbal, rate "0"*).	.69	.46	.88	.83
43	Use of facial expressions.*	.74	.62	.82	.70
44	Abnormal fascination with the movement of spinning objects (e.g., closing doors, electric fan blades).	.67	.40	.85	.76
45	Curiosity with surroundings.	.43	.22	.79	.64
46	Saying words and phrases repetitively (*If nonverbal, rate "0"*).	.76	.59	.79	.69
47	Make-believe or pretend play.	.69	.56	.79	.63
48	Understanding of age appropriate jokes, figures of speech, or sayings.*	.76	.70	.82	.81
49	Gives subtle cues or gestures when communicating with others (e.g., hinting).*	.74	.62	.79	.77
50	Becomes upset if there is a change in routine.*	.79	.74	.70	.66
51	Needs reassurance, especially if events don't go as planned.*	.76	.62	.67	.60
52	Language development.*	.85	.79	.94	.94

(table cont.)

53	Responds to others' distress.	.73	.59	.75	.71
54	Socializes with other children.*	.83	.75	.89	.83
55	Use of nonverbal communication.*	.76	.67	.73	.64
56	Clumsiness.	.76	.56	.82	.72
57	Limited number of interests.*	.76	.72	.82	.81
58	Imitation of an adult or child model (e.g., caregiver waves "bye" then the child waves "bye").	.69	.38	.79	.80
59	Abnormal, repetitive hand or arm movements.*	.73	.47	.79	.64
60	Body posture.	.71	.22	.85	.65
61	Abnormal, repetitive motor movements involving entire body.	.76	.46	.73	.46
62	Development of social relationships.*	.83	.73	.91	.91
63	Respect for others' personal space (e.g., stands too close to others).*	.76	.61	.85	.81
64	Isolates self (i.e., wants to be by him/her self).	.71	.59	.79	.74
65	Participation in games or other social activities.*	.73	.68	.82	.77
66	Speaks overly precise or scholarly (e.g., high vocabulary, speaks very properly).	.71	.42	.84	.71
67	Academic skills.	.57	.26	.75	.59
68	Reading above age/grade level.	.63	.43	.74	.66
69	"Over the top" vocabulary (sounds like a "little professor").	.66	.33	.88	.73
70	Has an exceptional memory (e.g., can memorize full passages, monologues, speeches, etc.).	.66	.52	.69	.48
71	Musical or artistic ability.	.69	.43	.72	.44

* Indicate the item was retained in the final scale, item inter-rater and test-retest reliability >/=.60.

Table 5
Inter-item and Item-scale Correlations of the ASD-DC (37 retained items)

Item	1	3	4	5	7	8	9	10	11	13	17	19	20	21	22	23	24	25	27	28	30	32	37
1	1.00																						
3	.73	1.00																					
4	.63	.69	1.00																				
5	.91	.74	.63	1.00																			
7	.57	.53	.53	.53	1.00																		
8	.62	.66	.75	.63	.48	1.00																	
9	.79	.64	.73	.73	.61	.76	1.00																
10	.87	.75	.58	.90	.50	.61	.68	1.00															
11	.80	.70	.70	.77	.57	.75	.80	.74	1.00														
13	.75	.74	.73	.72	.57	.80	.80	.66	.78	1.00													
17	.86	.69	.61	.87	.50	.69	.76	.90	.82	.71	1.00												
19	.76	.71	.72	.76	.49	.73	.76	.75	.87	.74	.78	1.00											
20	.73	.66	.62	.75	.52	.65	.65	.73	.85	.67	.78	.86	1.00										
21	.80	.72	.73	.80	.55	.74	.79	.75	.86	.79	.78	.87	.81	1.00									
22	.75	.75	.77	.72	.52	.84	.78	.70	.81	.84	.75	.79	.76	.88	1.00								
23	.77	.75	.71	.78	.52	.78	.73	.74	.81	.81	.77	.82	.76	.84	.82	1.00							
24	.64	.75	.67	.66	.52	.67	.62	.64	.69	.74	.61	.72	.65	.70	.70	.83	1.00						
25	.89	.75	.64	.93	.54	.64	.73	.92	.75	.70	.89	.75	.73	.76	.73	.76	.65	1.00					
27	.61	.72	.67	.60	.47	.66	.68	.62	.63	.75	.62	.66	.59	.66	.74	.70	.72	.63	1.00				
28	.78	.68	.72	.76	.60	.71	.76	.71	.80	.81	.79	.76	.76	.81	.80	.82	.70	.75	.74	1.00			
30	.74	.65	.75	.68	.51	.72	.89	.64	.76	.77	.71	.73	.68	.76	.78	.71	.61	.67	.71	.76	1.00		
32	.51	.57	.50	.48	.30	.48	.45	.56	.54	.50	.56	.52	.52	.49	.52	.44	.48	.52	.47	.51	.39	1.00	
37	.81	.74	.71	.81	.56	.76	.75	.80	.86	.78	.81	.87	.85	.86	.79	.87	.75	.80	.69	.85	.72	.59	1.00
38	.73	.75	.74	.72	.58	.79	.76	.69	.79	.82	.74	.80	.75	.88	.91	.81	.70	.70	.74	.78	.76	.44	.77
40	.53	.55	.59	.55	.39	.62	.57	.56	.58	.61	.61	.59	.63	.63	.65	.63	.57	.57	.59	.74	.60	.42	.62
43	.68	.76	.65	.69	.53	.67	.68	.70	.71	.74	.70	.71	.66	.75	.78	.76	.76	.72	.83	.78	.68	.54	.75
48	.80	.79	.74	.81	.57	.72	.74	.78	.82	.78	.78	.80	.74	.86	.85	.86	.74	.81	.73	.83	.73	.49	.84
49	.75	.82	.69	.74	.48	.74	.65	.78	.76	.77	.75	.75	.73	.79	.84	.85	.77	.77	.75	.77	.64	.56	.82
50	.72	.62	.71	.71	.65	.67	.69	.67	.74	.72	.71	.71	.72	.75	.70	.77	.68	.70	.65	.81	.70	.41	.78
51	.64	.69	.70	.64	.59	.63	.65	.63	.69	.69	.66	.67	.67	.69	.68	.70	.68	.67	.68	.77	.60	.46	.72
52	.91	.76	.60	.92	.48	.60	.71	.91	.75	.72	.86	.75	.74	.81	.74	.80	.66	.90	.63	.75	.67	.51	.80
54	.75	.67	.70	.72	.49	.72	.77	.68	.86	.80	.72	.86	.82	.79	.75	.82	.71	.71	.66	.75	.78	.43	.82
55	.71	.78	.65	.72	.52	.62	.67	.71	.69	.73	.68	.73	.69	.73	.73	.76	.74	.72	.74	.76	.64	.52	.75
57	.74	.68	.70	.72	.57	.70	.70	.67	.78	.75	.73	.73	.75	.76	.75	.81	.68	.73	.66	.89	.70	.49	.80
62	.78	.67	.75	.74	.59	.76	.79	.70	.86	.78	.75	.85	.83	.85	.81	.85	.73	.71	.68	.82	.81	.47	.85
63	.73	.70	.68	.69	.62	.62	.67	.68	.75	.73	.69	.70	.71	.74	.69	.75	.71	.70	.63	.73	.64	.54	.81
65	.72	.62	.63	.70	.56	.67	.75	.64	.79	.76	.70	.82	.82	.78	.72	.77	.69	.66	.62	.78	.73	.45	.80
Item-Scale	.87	.82	.79	.86	.62	.80	.84	.84	.90	.87	.87	.88	.85	.91	.89	.90	.80	.86	.78	.90	.82	.57	.92

(table cont.)

Item	38	40	43	48	49	50	51	52	54	55	57	62	63	65	Item-Scale
38	1.00														
40	.68	1.00													
43	.77	.65	1.00												
48	.83	.60	.81	1.00											
49	.84	.58	.82	.87	1.00										
50	.74	.72	.68	.76	.68	1.00									
51	.69	.70	.72	.72	.72	.84	1.00								
52	.75	.55	.72	.82	.81	.69	.64	1.00							
54	.78	.59	.71	.76	.73	.72	.70	073	1.00						
55	.77	.58	.79	.77	.81	.67	.71	.76	.74	1.00					
57	.71	.64	.73	.80	.78	.78	.79	.73	.75	.72	1.00				
62	.84	.60	.77	.83	.79	.78	.73	.76	.92	.74	.82	1.00			
63	.73	.47	.72	.78	.80	.72	.69	.73	.71	.71	.76	.78	1.00		
65	.75	.58	.72	.72	.69	.70	.71	.72	.89	.72	.80	.91	.73	1.00	
Item-Scale	.87	.69	.84	.91	.88	.84	.80	.87	.87	.83	.86	.91	.83	.85	1.00

Discussion

Study 1 aimed at evaluating the item and total scale inter-rater, test-retest, and internal consistency reliability of a newly developed, parent/caregiver-based rating scale for assessing symptoms of ASD in a sample of children with and without ASD. The reliability of the individual items of the ASD-DC was measured with weighted kappa. Initial inter-rater reliability coefficients on the item-level ranged from poor to excellent. Thirty-three items were found to have reliabilities that were less than optimal (κ_ω<.60). Initial item test-retest reliability coefficients were fair to excellent. There were seven items with test-retest coefficients below .60. For both the inter-rater and test-retest item analyses, there were 34 items that were not retained in the scale due to insufficient item reliability.

Mean inter-rater reliability for the 37 retained items was good, κ_ω = .68, with coefficients ranging from .60 to .85. Mean test-retest reliability for the 37 retained items was excellent, κ_ω = .79, with coefficient ranging from .60 to .94. Total scale reliabilities were also good to excellent with inter-rater reliability at r = .85 and test-retest reliability at r = .98.

Scale internal consistency was excellent with α = .99 (Cicchetti, 1994). Mean inter-item correlations were .71 (.30 to .93) and the mean item-scale correlations was .84 (.57 to .92), which are acceptable (Netemeyer, Bearden, & Sharma, 2003). In addition, items showed adequate variability and discrimination among individuals as there were no items with near-zero means or variances. Based on this initial study of psychometric properties of the ASD-DC, the reliability of this scale appears good.

Some limitations in regard to Study 1 should be noted. Though this occurred in only a small portion of the sample, there were informants who rated multiple children in the sample (i.e., 18 primary informants and 10 secondary informants rated two children in the sample). This could conflate the reliability and should be considered when interpreting these results. Further,

participants self-selected to participate in the inter-rater and test-retest portions of this study. Therefore, there may be a selection bias whereby those informants that were more motivated and/or more able to adequately complete the questionnaires provided the data from which the reliability coefficients were calculated. As there was not a random sample collected from the population, informants' ratings of these questionnaires may not be representative of the total population of informants. For example, based on the SES data collected within this sample, most informants for which reliability data was computed were in the Upper-Middle range of SES, with only a few in the Middle range of SES. It is quite possible that the reliability of these informants' ratings is dissimilar to ratings of informants who are from lower SES backgrounds. As SES data was collected only from a sub-sample of participants, it is uncertain that the SES data reported is representative of the entire sample. While it may be an approximation of the total sample SES, it is possible that participants with higher SES were more likely to return data regarding their marital status, education, and current employment.

STUDY 2

This study examined the construct validity of the ASD-DC by utilizing a correlation matrix first proposed by Campbell and Fiske (1959). This study aimed to evaluate the extent to which the ASD-DC (i.e., with the 37 retained items) adequately measures the construct of ASD which is characterized by impairments in social interactions, communication skills, and restricted/stereotyped interests or behavior. The convergent and divergent validity of this scale was examined by evaluating how well it correlates with other measures of ASD symptoms. Specifically, the ASD-DC was examined in comparison to a DSM-IV-TR/ICD-10 checklist of ASD symptoms. Moreover, the ASD-DC was examined in relation to social skill measures such as the Matson Evaluation of Social Skills with Youngsters (MESSY) and the Social Skills subscale of the Behavioral Assessment System for Children-2 (BASC-2); functional communication measures such as the Functional Communication subscale of the BASC-2; and other associated symptoms as measured by the Withdrawal and Atypicality subscales of the BASC-2. In addition, the ASD-DC was compared to the Depression subscale of the BASC-2 to demonstrate its lack of relation with a scale that does not measure symptoms of ASD.

Method

Participants

Ninety participants (45 in each group who were matched best as possible on variables of age and gender) from Study 1 were included in Study 2. As in Study 1, children ranged in age from 2 to 16. Mean age for the children included in this study was 7 years. Fifty-seven (63%) were male and 33 (37%) were female. Seventy (78%) were White, 12 (13%) were Black, 7 (8%) were Hispanic, and 1 child (1%) was from another ethnic background. Results of a chi-square test revealed significant group differences in terms of gender, X^2 (df = 1, N=90) = 5.79, p<.05.

However, a chi-square and an independent t-test revealed no ethnic or age difference between groups. Table 6 displays the age, gender, and ethnicity of the children in Study 2.

Table 6
Demographic Characteristics of Children in Study 2

	Group			
	ASD Group (*n*= 45)		Control Group (*n*=45)	
	N	%	*n*	%
Mean Age	8.09		7.36	
2 to 5 years (preschool)	12	27	13	29
6 to 11 years (child)	25	55	30	67
12 to 16 years (adolescent)	8	18	2	4
Gender				
Male	34	76	23	51
Female	11	24	22	49
Ethnicity				
White	32	71	38	84
Black	7	16	5	11
Hispanic	5	11	2	5
Other	1	2	0	0

SES data was collected for 54 informants (60%) participating in Study 2. The mean SES level for this group was Upper-Middle and ranged from Low-Middle to Upper levels of SES. There were 4 participants whose SES was in the Low-Middle range, 3 in the Middle range, 36 in the Upper-Middle range, and 11 in the Upper range. There was one informant who had achieved an education of junior high or middle school, all other had at minimum graduated from high school.

Measures

Autism Spectrum Disorder-Diagnostic (ASD-DC). As previously described in the methods section of Study 1.

DSM-IV-TR/ICD-10 checklist. As previously described in the methods section of Study 1.

Matson Evaluation of Social Skills with Youngsters (MESSY). The MESSY is a 64-item Likert-type rating scale designed to assess social behavior of children (Matson, Rotatori, &

Helsel, 1983). This widely used scale was developed for use with children ages 4 to 18. Items are rated on a scale of 1 (not at all) to 5 (very much). Though this scale has two versions, a self-report and a teacher-report form (i.e., this form can be used for all caregivers including parents; Matson, 1990), only the teacher-report form was used for the purposes of this study. Factor analytic studies yielded two factors for the teacher-report form: Inappropriate Assertiveness/Impulsiveness and Appropriate Social Skills. The Inappropriate Assertiveness/Impulsiveness subscale includes items such as "becomes easily angry" and "threatens people or acts like a bully." The Appropriate Social Skills subscale includes items such as "looks at people when they are speaking" and "works well on a team." All items have test-retest reliabilities of $r = .55$ or above. Good convergent and divergent validity has been demonstrated with the Child Behavior Checklist (Kazdin, Matson, & Dawson, 1984) and the Child Depression Inventory (Helsel & Matson, 1984). Further, the MESSY has been demonstrated to correctly distinguish between children with and without diagnoses (e.g., autism; Matson, Compton, & Sevin, 1991; conduct disorder; Kazdin, Matson, & Esvelt-Dawson, 1984). It has been used with a number of special populations, including children that are visually impaired, deaf, and have autism. (Matson, Heinze, Helsel, Kapperman, & Rotatori, 1986; Matson, Compton, & Sevin, 1991; Matson, Macklin, & Helsel, 1985). Scores that fall one standard deviation below the normative mean are considered "problematic," while scores that fall two standard deviations below the mean are considered "very problematic."

Behavior Assessment System for Children-2 (BASC-2*;* Reynolds & Kamphaus, 2004). The BASC-2 is a widely used broad-band assessment of clinical and adaptive dimensions in children ages 2 to 21 years. This assessment system was developed for the purposes of description, educational disability determination, diagnosis based on the DSM-IV, and in the

facilitation of treatment planning. The BASC-2 is an easy, efficient, and comprehensive assessment of child behavior.

There are different components of the BASC-2 including parent-ratings, teacher-ratings, and self-ratings. Each component has three forms: preschool (ages 2 to 5), child (ages 6 to 11) and adolescent (ages 12 to 21). Each item or behavior on the parent-rating form is rated from 1 (*never*) to 4 (*almost always)*. Items appear on one scale only. The dimensions rated include: aggression, hyperactivity, conduct problems, anxiety, depression, somatization, attention problems, learning problems, atypicality, withdrawal, adaptability, activities of daily living, functional communication, leadership, social skills, and study skills. For the purposes of the present study, the parent-ratings were used. As the participants in the present study were parents of children ages 2 to 16 years, the age-appropriate form (i.e., preschool, child, and adolescent) was utilized.

Internal consistency of the parent rating forms for this measure has been reported by the author's of the BASC-2 to be high, with composite scores ranging from α = .85 to .95 for general samples and .89 to .95 for clinical samples. Median values of internal consistency for the scale scores range from .80 to .83 for the preschool form, .83 to .87 for the child form, and .83 to .86 for the adolescent form. With a sample of 252 (87 preschool-aged, 77 children, 88 adolescents), test-retest reliability estimates for composite scores ranged from .76 to .92. For the individual scales, median test-retest reliability estimates were .77 for the preschool form, .84 for the child form, and .81 for the adolescent form. Inter-rater reliability was computed from a sample of 134 (40 preschool-aged, 43 children, and 51 adolescents). Composite score inter-rater reliabilities ranged from .70 to .88. Median inter-rater reliabilities were .74, .69, and .77 for preschool, child, and adolescent forms, respectively.

Studies examining the construct validity demonstrate a high similarity between the BASC-2 parent and teacher report forms and the Child Behavior Checklist parent and teacher report forms. Further, examinations of scale scores demonstrate distinct clinical profiles for groups of children with conduct disorder, behavioral disorders, depression, emotional disturbance, attention-deficit/hyperactivity disorder, learning disability, mild ID, and autism. The score profiles of groups of children with specific diagnoses provide further evidence of concurrent validity. Children whose clinical scale scores are one standard deviation above the mean are considered "at risk," while clinical scale scores two standard deviations above the mean are considered "clinically significant." Adaptive scale scores that are one standard deviation below the mean are considered "at risk," while adaptive scores two standard deviations below the mean are indicative of poor functioning.

This broad-band measure was chosen for the present study because of the available norms for children with ASD as well as other childhood disorders. The authors of the BASC-2 provide the mean scale scores of groups of children and adolescents who have been identified with behavioral or emotional problems. Though the authors report that the profiles of children with ASD differ, significant excesses on the Atypicality and Withdrawal scales were noted and significant deficits were noted on the Adaptability and Social Skills scales. This pattern of high scores on Atypicality and Withdrawal and low scores on Social Skills scales was also noted in a separate study by Lindner (2005), which evaluated the utility of the BASC-2 in identifying and distinguishing children with Asperger's Disorder from ADHD, Oppositional Defiant Disorder, and typically developing children. These previous findings provide a basis for the hypotheses in this study.

Procedures

The procedures for Study 2 are identical to those in Study 1. However, in addition to the DSM-IV-TR/ICD-10 checklist and ASD-DC included in Study 1, the MESSY and the BASC-2 were also included in the packet of questionnaires for informants. As in Study 1, parent informants completed these questionnaires independently and returned them either in person at the outpatient clinic or via mail in self-addressed, stamped envelopes.

Data Analysis

A convergent/divergent correlation matrix was computed with the SPSS statistical program using Pearson's *r*. This was done to evaluate the pattern of correlations when the ASD-DC is compared to the DSM-IV-TR/ICD-10 checklist, MESSY, and the Social Skill, Functional Communication, Atypicality, Withdrawal, and Depression subscales of the BASC-2. An *a priori* power analysis was conducted to determine the sample size required. The power analysis computer program GPOWER (Faul & Erdfelder, 1992) was used in order to determine the sample size necessary to detect a medium effect size of $r = 0.3$ for a two-tailed correlation (Cohen, 1992). In the behavioral sciences with an *a priori* level of significance (α) of .05, power should be set at .80 (Chase & Tucker, 1976). Results of the GPOWER power analysis indicated that a sample size of 82 is necessary to achieve power of .80 when α is set at .05.

Hypothesized Results

It was hypothesized that the ASD-DC would have high positive correlations (i.e. convergence) with the standard criteria used to evaluate ASD in the field, DSM-IV-TR/ICD-10 checklist. Further, as previous research has indicated that children with ASD tend to have high scores on the Withdrawal and Atypicality subscales of the BASC-2, it was expected that there would be a moderate to high positive correlation between the total ASD-DC score and these scales of the BASC-2. As social interaction is a core deficit of ASD, it is expected that measures

of social skills (Appropriate subscale of the MESSY and Social Skills subscale of the BASC-2) would be negatively correlated with the ASD total score. It was expected that the ASD-DC would have no association with the Inappropriate subscale of the MESSY as this is more a measure of inappropriate or excesses of anti-social behaviors (i.e., bullying others) rather than a measure of pro-social skills. Further, as communication is another deficit found in persons with ASD, it was expected that the ASD-DC total scale would have a high negative correlation with the Functional Communication subscale of the BASC-2. Lastly, it was expected that the ASD would have no association with the Depression subscale of the BASC-2 as the ASD-DC should measure symptoms of ASD, not depression. Table 7 includes a visual representation of the hypothesized pattern of correlations.

Results

A correlation matrix was computed with the data of the 90 participants in this study. High positive correlations were found for the ASD-DC and DSM-IV-TR/ICD-10 checklist (r = .94), BASC-2 Withdrawal (r = .73), and BASC-2 Atypicality (r = .85) subscales. High negative correlations were found for the ASD-DC and MESSY Appropriate subscale (r = -.87), BASC-2 Social skills (r = -.78), and BASC-2 Functional Communication subscales (r = -.81). Lower correlations were found between the ASD-DC and the MESSY Inappropriate (r = -.05) and the BASC-2 Depression (r = .29) subscales. The correlation matrix is presented in Table 8.

Next, the correlations were computed separately for children ages 2 to 5, 6 to 11, and 12 to 16 to examine whether the convergence/divergence pattern between the ASD-DC and these measures differs across ages. Similar patterns of correlations were found across the three age groups. The convergence and divergence of the ASD-DC with the other measures are presented in Table 9.

Table 7
The Hypothesized Pattern of Correlations in the Correlation Matrix

	ASD-DC	**DSM/ICD checklist**	**MESSY (Appropriate)**	**MESSY (Inappropriate)**	**BASC-2 (Social Skills)**	**BASC-2 (Functional Communication)**	**BASC-2 (Withdrawal)**	**BASC-2 (Atypicality)**	**BASC-2 (Depression)**
ASD-DC	1.0								
DSM/ICD Checklist	High positive	1.0							
MESSY (Appropriate)	High Negative	High Negative	1.0						
MESSY (Inappropriate)	No relation	No relation	No relation	1.0					
BASC-2 (Social Skills)	High Negative	High Negative	High Positive	No relation	1.0				
BASC-2 (Functional Communication)	High Negative	High Negative	Low-Moderate Positive	Low-Moderate Positive	Low-Moderate Positive	1.0			
BASC-2 (Withdrawal)	High-Moderate Positive	High-Moderate Positive	High Negative	No relation	High Negative	Low-Moderate Negative	1.0		
BASC-2 (Atypicality)	High-Moderate Positive	High-Moderate Positive	High-Moderate Negative	No relation	High-Moderate Negative	No relation	No relation	1.0	
BASC-2 (Depression)	No relation	No relation	Low-Moderate Negative	Low-Moderate Positive	Low-Moderate Negative	No relation	Low-Moderate Positive	No relation	1.0

Table 8
Correlation Matrix (*N*=90)

	ASD-DC	DSM/ICD checklist	MESSY (Appropriate)	MESSY (Inappropriate)	BASC-2 (Social Skills)	BASC-2 (Functional Communication)	BASC-2 (Withdrawal)	BASC-2 (Atypicality)	BASC-2 (Depression)
ASD-DC	1.0**								
DSM/ICD Checklist	.94**	1.0**							
MESSY (Appropriate)	-.87**	-.85**	1.0**						
MESSY (Inappropriate)	-.05	-.04	.04	1.0**					
BASC-2 (Social Skills)	-.78**	-.78**	.82**	.02	1.0**				
BASC-2 (Functional Communication)	-.81**	-.77**	.74**	.07	.76**	1.0**			
BASC-2 (Withdrawal)	.73**	.70**	-.69**	-.00	-.64**	-.63**	1.0**		
BASC-2 (Atypicality)	.85**	.86**	-.73**	.15	-.69**	-.75**	.66**	1.0**	
BASC-2 (Depression)	.29	.30	-.24	.60**	-.15	-.26	.39**	.46**	1.0**

** denotes $p<.001$.

Table 9
Convergence and Divergence of ASD-DC by Age Group

	ASD-DC		
	Ages 2 to 5	Ages 6 to 11	Ages 12 to 16
	(*n*=25)	(*n*=55)	(*n*=10)
DSM-IV-TR/ICD-10	.90**	.97**	.86**
MESSY (Appropriate)	-.94**	-.88**	-.64*
MESSY (Inappropriate)	-.46*	.02	.04
BASC-2 (Social Skills)	-.85**	-.79**	-.83**
BASC-2 (Functional Communication)	-.82**	-.79**	-.85**
BASC-2 (Withdrawal)	.64*	.78**	.89**
BASC-2 (Atypicality)	.80**	.89**	.62*
BASC-2 (Depression)	.19	.20	.14

** denotes $p<.001$, * denotes $p<.05$.

Subsequently, a median split for the SES level of informants was made to create high and low SES groups. The total ASD-DC scale correlation with the other variables was compared across groups to examine if there were differences based on SES level. A Bonferroni correction procedure was utilized to decrease inflation in alpha-wise error rate since multiple t-tests were conducted, thus α was set at .006 for these comparisons. T-tests revealed significant differences between high and low SES groups. There were significant SES group differences in correlations between the ASD-DC and the MESSY Inappropriate subscale, t (df = 51) = 6.36, $p<.001$; and the ASD-DC and the BASC-2 Depression subscale, t (df = 52) = 3.71, $p<.001$. Despite significant differences in correlations between high and low SES groups (i.e., lower correlations among these subscales in the lower SES group), the overall patterns of correlations of both groups were similar to each other and to the entire sample matrix. The correlations matrix of the high SES group is displayed in Table 10.

Table 10
Correlation Matrix of those with Higher SES (SES score > 48.50; *n* = 27)

	ASD-DC	**DSM/ICD checklist**	**MESSY (Appropriate)**	**MESSY (Inappropriate)**	**BASC-2 (Social Skills)**	**BASC-2 (Functional Communication)**	**BASC-2 (Withdrawal)**	**BASC-2 (Atypicality)**	**BASC-2 (Depression)**
ASD-DC	1.0**								
DSM/ICD Checklist	.91**	1.0**							
MESSY (Appropriate)	-.82**	-.82**	1.0**						
MESSY (Inappropriate)	-.01	.02	.17	1.0**					
BASC-2 (Social Skills)	-.79**	-.82**	.89**	.03	1.0**				
BASC-2 (Functional Communication)	-.84**	-.75**	.64**	-16	.75**	1.0**			
BASC-2 (Withdrawal)	.86**	.74**	-.72**	.03	-.77**	-.79**	1.0**		
BASC-2 (Atypicality)	.81**	.80**	-.60**	.23	-.62**	-.80**	.67**	1.0**	
BASC-2 (Depression)	.19	.18	.05	.69**	-.01	-.35*	.14	.46*	1.0**

** denote $p<.001$, * denotes $p<.05$.

Finally, as the ASD-DC was developed as a measure of ASD symptoms it should distinguish between groups of children with and without ASD. To examine this question, a t-test was conducted between ASD and control groups. Significant mean differences were found between groups; t (df = 51.13) = 15.423, p<.001. Table 11 displays the mean, standard deviations, range, and median of ASD-DC scores for each group.

Table 11
Mean, Standard Deviation, Range, and Median of ASD-DC Scores

	ASD-DC Total Sum		
	Mean (SD)	Range	Median
ASD (n=45)	46.31 (18.30)	3 to 74	52.0
Control (n=45)	2.56 (5.22)	1 to 22	0.0

Since the ASD group in this study varied in terms of symptoms (i.e., DSM-IV-TR/ICD-10 Checklist score ranging from 3 to 18, ASD-DC total sum ranging from 3 to 74, and included those that met minimum criteria of PDD-NOS), the pattern of correlations were analyzed with smaller yet more homogeneous groups of participants with symptoms of ASD. First, participants with DSM-IV-TR/ICD-10 checklist symptoms at or above the 75th percentile were selected for analysis. This included 23 participants with DSM-IV-TR/ICD-10 checklist total endorsement of 11 or above. A correlation matrix was computed with this high DSM-IV-TR/ICD-10 symptom group. A similar pattern of correlations were noted; however, correlations were less extreme. Second, there were 17 children with whom informants reported a previous diagnosis of Autistic Disorder given by a psychologist and/or medical professional prior to the study. A correlation matrix was computed with this group of children previously diagnosed with Autistic Disorder. Again, a similar pattern of correlations emerged. Table 12 and 13 display the correlations of those with High DSM-IV-TR/ICD-10 endorsements and previous diagnoses of Autistic Disorder.

Table 12
Correlation Matrix of Participants with Higher DSM-IV-TR/ICD-10 Symptoms (*n* = 23*)*

	ASD-DC	DSM/ICD checklist	MESSY (Appropriate)	MESSY (Inappropriate)	BASC-2 (Social Skills)	BASC-2 (Functional Communication)	BASC-2 (Withdrawal)	BASC-2 (Atypicality)	BASC-2 (Depression)
ASD-DC	1.0**								
DSM/ICD Checklist	.55*	1.0**							
MESSY (Appropriate)	-.50*	-.25	1.0**						
MESSY (Inappropriate)	-.53*	-.27	.62*	1.0**					
BASC-2 (Social Skills)	-.35	-.12	.33	.32	1.0**				
BASC-2 (Functional Communication)	-.60*	-.35	.44*	.40*	.41*	1.0**			
BASC-2 (Withdrawal)	.08	.20	-.03*	.08	-.44*	-.27	1.0**		
BASC-2 (Atypicality)	.18	.29	-.04	.30	-.25	-.44*	.51*	1.0**	
BASC-2 (Depression)	-.27	.12	.40*	.75**	.38*	-.24	.04	.38*	1.0**

** denotes $p<.001$, * denotes $p<.05$.

Table 13
Correlation Matrix of Participants with a Previous Diagnosis of Autistic Disorder (*n*=17*)*

	ASD-DC	**DSM/ICD checklist**	**MESSY (Appropriate)**	**MESSY (Inappropriate)**	**BASC-2 (Social Skills)**	**BASC-2 (Functional Communication)**	**BASC-2 (Withdrawal)**	**BASC-2 (Atypicality)**	**BASC-2 (Depression)**
ASD-DC	1.0**								
DSM/ICD Checklist	.67**	1.0**							
MESSY (Appropriate)	-.41*	-.55**	1.0**						
MESSY (Inappropriate)	-.40*	.40*	.53*	1.0**					
BASC-2 (Social Skills)	-.69**	-.58*	.70**	.57*	1.0**				
BASC-2 (Functional Communication)	-.84**	-.58*	.35	.23	.63*	1.0**			
BASC-2 (Withdrawal)	.23	.10	-.11	.05	-.36	-.36	1.0**		
BASC-2 (Atypicality)	.42**	.56*	-.23	-.04	-.35	-.59*	.33	1.0**	
BASC-2 (Depression)	.29	-.22	.45*	.42*	-.65*	-.25	.10	.07	1.0**

** denotes $p<.001$, * denotes $p<.05$.

Discussion

The goal of Study 2 was to examine the construct validity of the ASD-DC. To meet this aim, the convergence and divergence of the ASD-DC with other measures of ASD, symptoms associated with ASD, and non-ASD measures were examined with a correlation matrix using Pearson's r. The resulting pattern of convergence and divergence between the ASD-DC and the other measures were consistent with hypotheses. The ASD-DC showed good convergence (r = .94) with the DSM-IV-TR/ICD-10 checklist which is considered the diagnostic standard by which psychological and medical professionals identify ASD. Furthermore, as described in previous studies (Lindner, 2005), persons with symptoms of autism (i.e., for this study high scores on the ASD-DC) also had relatively high scores on the Withdrawal (r = .73) and Atypicality (r = .85) subscales of the BASC-2. Divergence was observed between the ASD-DC and measures of social skills (MESSY Appropriate subscale, r = -.87; Social Skill subscale of the BASC-2, r = -.78) and functional communication (as measured by the BASC-2 Functional Communication subscale, r = -.81). Finally, as predicted, little to no association was observed between the ASD-DC and the MESSY Inappropriate subscale (r = -.05) nor the Depression subscale of the BASC-2 (r = .29).

Further analysis revealed that this pattern of correlations largely persisted across children when divided into three age groups. In addition, when groups were separated into high and low SES groups to evaluate whether SES would be a confounding variable, the correlation patterns of both the high and low SES groups paralleled that of the matrix of the entire sample.

Moreover, significant mean ASD-DC total score differences were found between ASD and control groups. However, it was noted that the standard deviation of the ASD group was large. Though overall significantly different from the control group, the ASD group participants

had ASD-DC total scores ranging from 3 to 74, thus indicating much variability within this group.

As the criteria for ASD group inclusion were set at the minimum criteria listed in the DSM-IV-TR (APA, 2000) for PDD-NOS, and the ASD group was found to have variability in the ASD-DC total score, the convergence and divergence of the ASD-DC with the other measures were evaluated on two more conservative, and homogenous sub-samples of children within the ASD group. The first was a sub-sample of children with DSM-IV-TR/ICD-10 endorsements of 11 or above (i.e., 75th percentile of the entire sample), the second was a group of children who had been identified by informants as having a diagnosis of Autistic Disorder from a mental health/medical professional prior to the study.

The matrices for both of these more homogeneous sub-samples revealed patterns of correlations that were in the hypothesized direction, although many of the correlations were not as extreme as the previous analyses. This was not unexpected as there were less variance in these analyses due to the smaller number of participants (i.e., n = 23, 17, respectively). There was moderate convergence with the DSM-IV-TR/ICD-10 checklist, and moderate to low convergence (in the positive direction) with the Withdrawal and Atypicality subscales of the BASC-2. Further, moderate to low divergence (in the negative direction) was observed with the MESSY Appropriate subscale, Social Skills subscale, and Functional Communication subscales of the BASC-2. For these sub-samples, the correlation with the Depression subscale of the BASC-2 was a little higher than in previous analyses, but still not statistically significant. However, the correlation of the MESSY Inappropriate subscale was higher and statistically significant in these analyses, revealing a divergence with the ASD-DC. As many children with Autistic Disorder and/or more severe ASD symptoms may not have the social or communication

skills to interact with others, they may also exhibit fewer inappropriate social behaviors or excesses (i.e., teasing or bullying others) which may be why divergence between this subscale and the ASD-DC is observed in these more homogeneous sub-sample of ASD group participants.

Overall, the convergence/divergence pattern of correlation were similar to what was hypothesized and persisted across sub-samples of participants including those with higher and lower SES, across different age groups, and with more homogeneous samples of ASD children. These findings lend support to the construct validity of the ASD-DC. Based on these findings, it appears that the ASD-DC converges with measures of autism (i.e., DSM-IV-TR/ICD-10 Checklist) and other subscales that have been found to previously be associated with ASD, and diverges with positive ratings of social skills and functional communication skills. Finally, the ASD-DC was found to have little to no relation with a scale that measures symptoms not associated with ASD (i.e., depression). While these findings are promising for this measure, there may be other measures available for comparison that would more narrowly assess the core symptoms of Autism than those used in this study (i.e., MESSY and BASC-2). For instance, the BASC-2, is a broadband measure of clinical dimensions and adaptive skills in children. A more narrow-band measure of core symptoms of Autism (i.e., social skills, communication, repetitive behavior) or symptoms expected to diverge with ASD may be a better tool to assess convergent and divergent validity.

IMPLICATIONS AND FUTURE DIRECTIONS

These studies were the initial study of the psychometric properties of the ASD-DC, an informant-based, rating-scale assessing symptoms of ASD in children. Study 1 examined the reliability of the ASD-DC individual items and the total scale. Thirty-seven items were retained in the scale after initial reliability analysis. Overall, the results indicate good inter-rater reliability, excellent test-retest reliability, and excellent internal consistency. Inter-item and item-scale correlations were also relatively high.

Study 2 evaluated the construct validity of the ASD-DC by examining how it related to other measures of the core deficits associated with ASD. As hypothesized, the ASD-DC converged with the DSM-IV-TR/ICD-10 checklist, and subscales previously associated with ASD. Further, the ASD-DC diverged with measures of social skills and functional communication. In addition, it was found to have no relationship with a measure of depression, as was expected. The convergence/divergence pattern of correlations was observed in the entire sample of participants and in more homogenous groups within the ASD group participants. Findings from Study 2 lend support to the construct validity of the ASD-DC.

As previously mentioned, this study is not without limitations. A major limitation of this study is that children were selected into the ASD group based on the informants' rating of a DSM-IV-TR/ICD-10 checklist. This was utilized because it was a standardized and efficient method of identifying children for the ASD group for research purposes without requiring informants to visit the clinic. Although the DSM-IV-TR/ICD-10 is the standard with which professionals base diagnoses of ASD; it is possible that it may be misinterpreted by informants who are not trained in this area. Reliability analysis of the DSM-IV-TR/ICD-10 checklist indicated that overall checklist inter-rater reliability was good ($r = .89$) and test-retest reliability

was excellent (r = .97), while internal consistency was also excellent (α = .95). Subsequent analyses revealed this checklist resulted in a heterogeneous ASD group that included children with previous diagnosis of Autistic Disorder, PDD-NOS and Asperger's Disorder, as well as other children who had other diagnoses or no diagnosis but met the research criteria. As this was an initial study evaluating reliability and measures were taken to look at more homogeneous sub-samples of ASD participants, the author suggests that this limitation was not fatal to the contribution of this initial study. Future studies should utilize standardized and more conservative methods that are widely recognized in the ASD literature to select participants into groups. These methods may include clinical diagnosis done systematically by a licensed psychologists, or use of pre-specified cut-offs on available measures such as the Autism Diagnostic Interview-Revised, Autism Diagnostic Observation Schedule – Generic, and the Childhood Autism Rating Scale.

Another limitation is that informants were not blind to the purpose of this study. Therefore, informants may have inflated or deflated their endorsements based on their perception of the child and what they know about autism, rather than the actual behaviors that the child exhibits. To avoid this possible confound, future studies should aim to have selection criterion that is gathered separately from the ratings on the ASD-DC.

Thirdly, as this was not a random sample, the findings reported in this study may not be representative of the total population. Children in the ASD group were mainly recruited through outpatient clinics, many of which were those who were being referred for services outside of the services provided through the school system. In addition, control group participants may have self-selected to participate because they wanted to receive the feedback regarding their child's performance in the study. Further, informants for this study were recruited mainly in Louisiana

through outpatient clinics, participant and professional referrals, support/advocacy groups, and school systems. It is likely that participants self-selected to participate in the study for one reason or another (i.e., to obtain professional feedback or additional services for their child). Consequently, it is important that future studies re-examine these findings to evaluate whether they generalize to other samples of children with ASD.

Overall, the findings of these initial investigations into the psychometric properties of the ASD-DC are promising and indicate that further investigation of the scale's properties is warranted. Future studies should aim to conduct a factor analysis to determine the factor structure of the scale and further examine properties of reliability. In addition, the validity of this measure should be investigated including additional examinations of construct validity, as well as criterion-related validity. Further, the specificity and sensitivity of this scale in identifying those with ASD should be examined, as well as the usefulness of the ASD-DC to adequately distinguish between ASD and other disorders such as intellectual disabilities and social anxiety in typically developing children.

Future studies should also aim to determine if the ASD-DC can discriminate between different types of ASD, such as Autistic Disorder, PDD-NOS, and Asperger's Disorder. Finally, norms of the ASD-DC should be established that are representative of the national population. As more children are being identified with ASD, efficient and effective methods of assessment are needed to serve this growing population of children. As there remains some difficulties in making differential diagnoses of ASD within the spectrum as well as with other childhood disorders, a reliable and valid rating scale developed with this aim would lead to prompt and effective referral to appropriate intervention services. More research is needed to clarify how ASDs should be defined and distinguished. The professional standard, DSM-IV criteria, is not

congruent with much of the current research regarding the assessment of ASDs. Future studies, similar to the current study, should continue to investigate psychometrically sound (both reliable and valid) and efficient ways of assessing ASD.

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APPENDIX A
DSM-IV-TR/ICD-10 CHECKLIST

Please indicate "yes" if the following applies to your child/client. Indicate "no" if the item does not apply to your child/client.

1. Impairment in social interaction, such as:

____ a. Impairment in the use of multiple nonverbal behavior, such as eye-to-eye gaze (e.g., eye contact), body posture, or gestures[a, b]

____ b. Failure to develop peer relationships appropriate to developmental level (e.g., little to no interest in forming friendships or lack understanding of how to interact socially with others)[a, b]

____ c. Lack of spontaneous seeking to share enjoyment, interest or achievements with others (e.g., not showing, bringing, or pointing out objects of he/she finds interesting)[a]

____ d. Lack of social or emotional reciprocity (e.g., not actively participating in social play or games, preferring solitary activities)[a, b]

____ e. Rarely seeking or using others for comfort in times of stress or offering comfort or affection to others in stress[c]

2. Impairments in communication, such as:

____ a. Delay in development or lack of spoken language (i.e., not accompanied by an attempt to communicate through alternative ways to communicate such as gestures or mime)[a,b]

____ b. In those with adequate speech, impairment to initiate or sustain conversations with others[a,b]

____ c. Stereotyped and repetitive use of language or idiosyncratic language (e.g., using words in a peculiar or odd way)[a,b]

____ d. Lack of varied, spontaneous make-believe play (e.g., pretend play) or social imitative play (e.g., imitating adults) appropriate to developmental level[a]

____ e. Lack of emotional response to others' verbal or non-verbal communication[c]

____ f. Lack of variation in the rhythm or emphasis of speech (e.g., speech is monotone; without change)[b]

____ g. Impaired use of gestures to aid spoken communication[c]

3. Restricted, repetitive and stereotyped patterns of behavior, interest or activities such as:

____ a. Preoccupation with one or more stereotyped and restricted patterns of interest of abnormal intensity or focus (e.g., few interests)[a,b]

____ b. Inflexible adherence to specific, nonfunctional routines or rituals[a,b]

____ c. Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or other complex whole-body movements such as rocking, dipping or swaying)[a,b]

____ d. Persistent preoccupation with parts of objects (e.g., buttons, parts of the body)[a,b]

____ e. Specific attachments to unusual objects (e.g., string)[c]

____ f. Distress over changes in small, non-functional details of the environment[b]

4. _____ Delays or abnormal functioning in at least one of the previous areas (#1-3) was present prior to age of 3[a,b]

[a] DSM-IV-TR diagnostic criteria; [b] ICD-10 diagnostic criteria; [c] Items are included in descriptions of ICD-10 for clinical use, but not included as specific diagnostic criteria

APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE REGARDING SES

Information About You and Your Family

Please answer the following questions about you and your family. Read each question carefully.

Relation to child: _____ **Are you the biological parent of your child?** ____ Yes ____ No

Your Age: _____ **Your Spouse's Age (if relevant):** _____

Your Race (indicate with an X below):
___ White
___ Black
___ Hispanic
___ Asian
___ Native American
___ Pacific Islander
___ Other

Marital Status:
___ Never Married
___ Married
___ Separated
___ Divorced
___ Widowed

Education: What is the highest level of education completed (indicate with an X below)

Yourself	Your Spouse (if applicable)
_____ 6th grade or less	_____ 6th grade or less
_____ Junior High/Middle School (7th, 8th, 9th grade)	_____ Junior High/Middle School (7th, 8th, 9th grade)
_____ Partial High School (10th or 11th grade)	_____ Partial High School (10th or 11th grade)
_____ High School Graduate	_____ High School Graduate
_____ Partial College (at least 1 year) or specialized training	_____ Partial College (at least one year) or specialized training
_____ University Graduate	_____ University Graduate
_____ Graduate degree (Master's or Doctorate)	_____ Graduate degree (Master's or Doctorate)

Occupation: Please indicate your current **job position or title**. NOT the name of your employer. If you are retired, please write "retired" and your past occupation. If you are not currently employed, write "unemployed". If you are a full time student, write "student".

What is your occupation?_____

What is your spouse's occupation? _____

Information About Your Child

Did you notice anything unusual about your child's early development? ____Yes ____ No

If yes, briefly describe _____

Was there a period of time during development that your child lost skills (unable to do something that he/she previously was able to do)? ___ Yes ___ No

If yes, what types of skills were lost? _____

If yes, at what age did this skill loss occur? (age in months) _____ months

If yes, how long did your child continue to lose skills before he/she stopped losing skills (skills stabilized)? (indicate with an X)
____ less than 1 month
____ 1-3 months
____ more than three months → How long did he or she continued to lose skills? _____ (months)

VITA

Melissa González was born in December 1978, in Centerville, Louisiana. She earned her Bachelor of Science degree in psychology and graduated with upper division honors and summa cum laude in May 2001 from Louisiana State University. She enrolled in the clinical psychology graduate program at Louisiana State University in August of 2003. Her research and clinical work focused on the assessment and treatment of psychopathology and behavior problem in persons with developmental disabilities. She completed her master's thesis entitled *Mania and Intellectual Disability: The Course of Manic Symptoms in Persons with Intellectual Disability Over Three Years* and received her Master of Arts degree in 2005. She completed her pre-doctoral internship at Kennedy Krieger Institute, Johns Hopkins School of Medicine. While training at Kennedy Krieger Institute, she further developed her clinical skills and knowledge of applied behavior analysis while working at the Pediatric Feeding Disorders Program and the Neurobehavioral Inpatient Program. Presently, she is completing a post-doctoral fellowship at Johns Hopkins School of Medicine with the Neurobehavioral Inpatient Program at Kennedy Krieger Institute.